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This guide, developed by a panel of teacher consultants, is a correlation of educational media resources with the "North Carolina Curricular Bulletin for Eighth Grade Earth and Space Science" and the state adopted textbook, pModern Earth Science." The three major divisions are (1) the Earth in Space (Astronomy), (2) Space Exploration, and (3) Meterology. Included for the primary topics under each division are (1) statements of concepts, (2) student activities, and (3) annotated listings of films, filmstrips, film-loops, transparencies, slides, and other forms of instructional media. Appendixes are (1) a directory to sources of instructional media, (2) a title index to the films and filmstrips cited, (3) a listing of bibliographies, guides, and printed materials related to aerospace education. (RS)

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SPACE SCIENCE Educational Media Resources

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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A Guide for Junior High School Teachers

A Report Submitted to
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATI

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SPACE SCIENCE EDUCATIONAL MEDIA RESOURCES

A Guide for Junior High School Teachers

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Compiled as a Teaching Resource Supplement

To the Earth Science Curriculum Bulletin

Of the State Department of Public Instruction

Raleigh, North Carolina

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INTRODUCTION

Space Science Educational Media Resources--A Guide for Junior High School Teachers is a correlation of educational media resources with the North Carolina Curriculum Bulletin for Eighth Grade Earth and Space Science, and the State adopted textbook, Modern Earth Science, edited by W. L. Ramsey and R. A. Burkley, New York: Holt, Rinehart and Winston, Inc., 1961.

Materials listed in this Guide were selected by a committee of teachers who were nominated by the science supervisors of the State Department of Public Instruction. After being selected for their teaching excellence and interest in space science education, these teachers served as consultants to the Bureau of Audiovisual Education during the period of its contract with the National Aeronautics and Space Administration"... for a space science Audiovisual Media Workshop to select, produce and evaluate Audiovisual Media and other materials for a space science curriculum for Eighth Grade instruction in North Carolina schools."

After the panel of teacher-consultants was selected in the fall of 1963, evaluative criteria for the selection of educational media was agreed upon during a series of interviews and conferences. Since all of the teachers selected for the project were actively engaged in instruction at their respective junior high Schools, preliminary screening techniques were implemented for the in-service use of space science materials. Efforts were made to identify the major sources of media available from commercial producers and/or governmental agencies in addition to free and inexpensive materials sponsored by the aerospace industry.

During the eight-month period prior to the June Workshop, the teacher-consultants were provided with a packet of space science publications, fliers on educational films with space science content, and indexes of free and inexpensive materials distributed by governmental agencies and industrial organizations. Every effort was made to select materials that had been used in-service by the teacher-consultants in order to assemble media and materials to be used during the Workshop evaluation period. Establishing criteria and procedures was the first goal of the Workshop staff.

In order to establish objectives in terms of pupil behavior, the following questions were posed: (1) What is it we want to teach? (2) What materials will work best to teach what we wish to teach? and (3) How will we know when we have taught it? From this point we proceeded to establish criteria which would accomplish our behavioral objectives. The outcome of the Workshop was a carefully evaluated list of materials which were edited and organized into this Guide for Junior High School Teachers.

The next procedure for the Workshop staff was to discuss evaluation techniques and to become familiar with the criteria established by the evaluation instrument.

The actual mechanics of screening out the relevant material and selecting those items which were most appropriate involved the major portion of the Workshop schedule. The final annotations were prepared and the materials were assembled under the major space sciences curriculum headings, The Earth In Space (Astronomy), Space Exploration, and Meteorology.

On completion of the Space Sciences Educational Media Workshop, the fall semester was used to test, in-service, selected items such as 8mm film loops, programmed instruction, 35mm film strips, and 16mm motion picture films on space science. A teaching demonstration using graphic examples of the methods by which established behavioral objectives could be achieved was given. Some of the techniques developed during the Workshop were recorded on video tape for an educational television program. The individual materials, annotated in the body of the Space Science Guide, are correlated with related subject matter headings.

To paraphrase a recent statement by Margaret Mead, we are teaching pupils things today which no one knew yesterday, but which some one must know tomorrow. It is the purpose of this Space Science Educational Media Resources Guide to help teachers meet this challenge as we explore Space - the New Frontier.

NOTE: None of the material included in the Space Science Educational Media Resources Guide for Junior High School Teachers constitutes an endorsement by any division of the University of North Carolina or the National Aeronautics and Space Administration, nor is there any intention to imply that materials, which were not available, were in any way less appropriate because they were not included. This is merely a guide for teachers with many suggested sources of information and material.

Kenneth M. McIntyre

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TABLE OF CONTENTS

INTRODUCTION. ii

ACKNOWLEDGMENTS 1

THE EARTH IN SPACE (ASTRONOMY). 9

A. The Solar System. 22

B. The Earth (A Planet in Motion). 25

C. The Moon. 28

D. The Sun. 36

E. The Stars, Constellations and Galaxies. 39

SPACE EXPLORATION 47

A. Space Travel 52

B. Rocketry and Space Vehicles 57

C. Man's Satellites. 61

D. Moon Flight 64

METEOROLOGY. 69

A. Nature of the Atmosphere. 82

B. Heating and Cooling of the Atmosphere 83

C. The Atmosphere's Changing Pressure. 84

D. Water Vapor Enters and Leaves the Atmosphere. 84

E. Air Masses and Their Weather. 86

F. The Weather Bureau and Its Work 87

APPENDICES

APPENDIX A. Source List. . . . . A (1-2)

APPENDIX B. Title Index of 16mm Films and 35mm Filmstrips. . . . B (1-4)

APPENDIX C. Sources of Materials: Bibliographies and Guides . . C (1-9)

APPENDIX D. Supplementary List of Films and Filmstrips D (1-3)

Course of Study for Eighth Grade Earth Science

The Earth Science course of study as presented in this curriculum bulletin is concerned with a combination of subject areas that deal with the scientific phenomena of the physical earth and its environs including the atmosphere, lithosphere and hydrosphere. Specific topics include fundamental elements of physical geography, astronomy, meteorology, oceanography and geology.

Instruction in Earth Science at the eighth grade level contributes greatly to the goals in science education. The study of the earth and its environs affords excellent opportunities for eighth grade students to understand and appreciate the world in which they live; it provides the pupil with an understanding of the physical earth and the space that surrounds it; it provides opportunities for the pupil to use the scientific method of solving problems; it provides the basis for an appreciation of the natural resources of our State and nation; it has aesthetic value in that travel becomes meaningful through an understanding of the physical features of the earth; it may serve as a beginning for the interest of students in occupations and careers.

The eighth grade course in Earth Science has been developed to present a variety of ideas and activities. The teacher may use the activities to lead the students in discovering relationships and in understanding a number of fundamental generalizations. Some of the activities are for teacher demonstrations, but the great majority are designed for student participation. Good science instruction involves active participation in laboratory activities on the part of the student. The order of topics may be varied or altered at the discretion of the teacher. However, it is suggested that opportunities for stressing interrelations of the various topics be an integral part of planning the year's course.

The course outline as developed for use in grade eight suggests many principles of Earth Science and supporting activities including field trips which can be developed in and out of the classroom. Topics considered include:

- THE ORIGIN OF THE EARTH, presented as a series of theories for investigation as a possible beginning of the universe;
- THE EARTH IN SPACE embraces elementary astronomy and is limited to a study of the Solar System and the place of the earth in the Sun's family with SPACE EXPLORATION being considered as a related topic;
- STRUCTURE AND COMPOSITION OF THE EARTH, AND EARTH PROCESSES compose the physical geology section. Attention is given to TOPOGRAPHIC MAPS as a major tool used in studying landforms;
- METEOROLOGY is presented as a study of the atmosphere, weather and climate, with attention given to the basic physical principles involved;
- OCEANOGRAPHY, as presented, includes the physical geography of the oceans and the effects of the ocean currents on the earth's surface;
- ERAS OF GEOLOGIC HISTORY gives attention to geologic time measurement and the historical development of life.

Suggested Course Outline For Earth Science

I. **ORIGIN OF THE EARTH (8-1)**

II. **THE EARTH IN SPACE (8-2—8-21)**
    A. The Solar System
    B. The Earth (A planet in motion)
    C. The Moon
    D. The Sun
    E. The Stars, Constellations and Galaxies

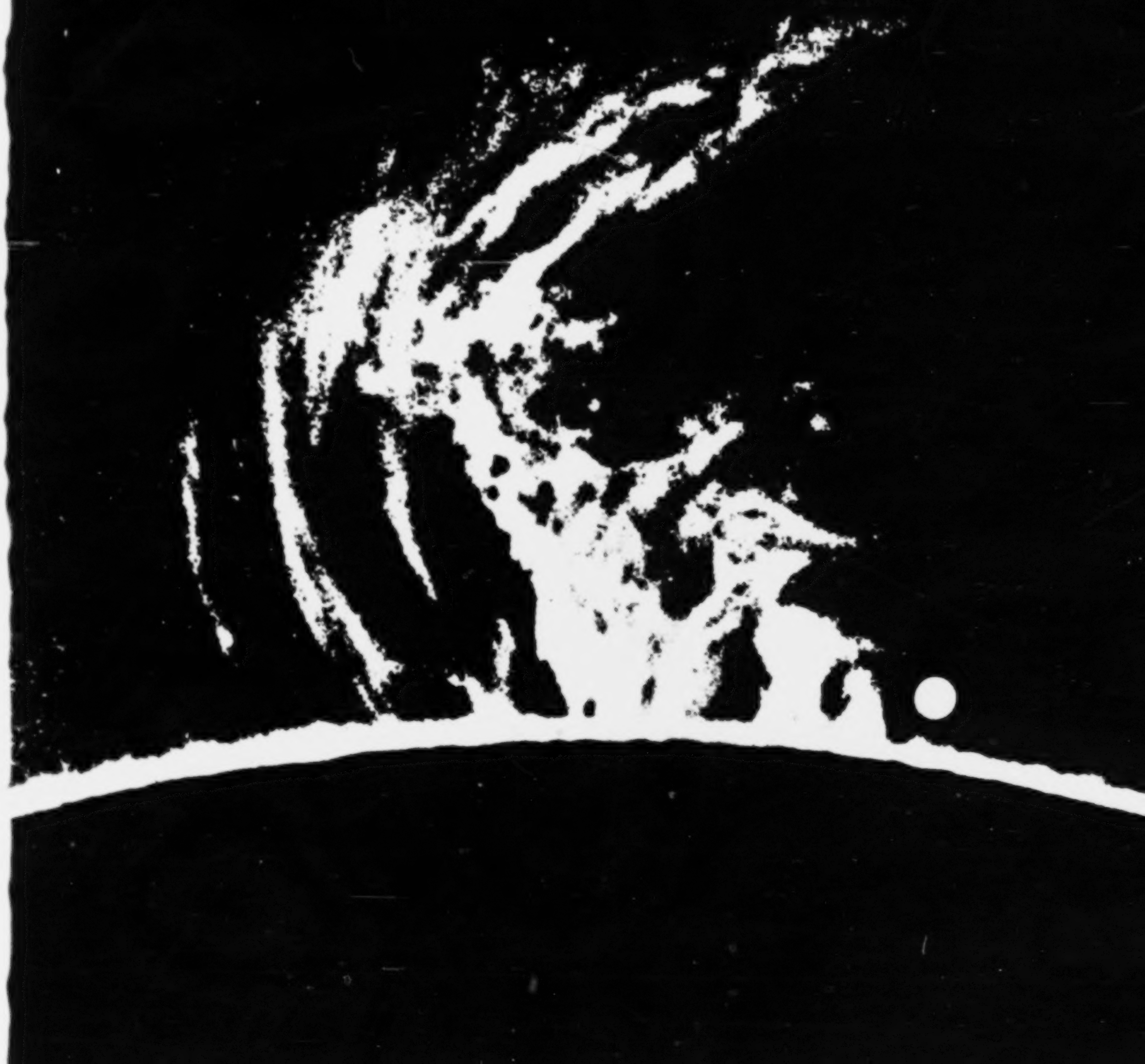
III. **SPACE EXPLORATION (8-22—8-26)**

IV. **STRUCTURE AND COMPOSITION OF THE EARTH (8-27—8-49)**
    A. Spheres of the Earth
    B. Chemical Elements
    C. Chemical Compounds
    D. Basic Chemical Reactions
    E. Minerals
    F. Rocks

V. **TOPOGRAPHIC MAPS (8-50—8-55)**

VI. **EARTH PROCESSES (8-56—8-99)**
    A. Internal
        1. Volcanoes

THE EARTH IN SPACE (Astronomy)



ASTRONOMY (89)

This photo shows flares rising from the surface of the sun. Astronomers call them "prominences". They may last several hours or longer, and may be as large as the sun itself. The white dot superimposed over the lower right represents the earth in scale. This photograph was made at the Mount Wilson-Palomar observatory in California. NASA's Orbiting Solar Observatory may yield additional information on such phenomena.

North Carolina State Department of Public Instruction Curriculum Bulletin
Suggested Principles and Activities for Eighth Grade Space Science

THE EARTH IN SPACE (ASTRONOMY)

(Paragraphs 8-2 through 8-20)

    2. Intrusive activities
    3. Earthquakes
    4. Formation of major landforms
- B. External
    1. Weathering
    2. Work of streams
    3. Work of underground water
    4. Work of wind
    5. Work of ice
    6. Formation of soil

VII. METEOROLOGY (8-100—8-125)

- A. Nature of the Atmosphere
- B. Heating and Cooling of the Atmosphere
- C. The Atmosphere's Changing Pressure
- D. Water Vapor Enters and Leaves the Atmosphere
- E. Air Masses and Their Weather
- F. The Weather Bureau and Its Work
- G. Factors that Control Climate

VIII. OCEANOGRAPHY (8-126—8-138)

- A. Ocean Floor
    1. Major features
    2. Charting
- B. Ocean Currents
    1. Cause
    2. Effects
- C. Physical and Chemical Properties of Sea Water
- D. Economic Importance of the Sea

IX. ERAS OF GEOLOGIC HISTORY (8-139—8-144)

- A. Geologic Time Measurement
- B. Geologic History of Life

Suggested Principles and Activities For Eighth Grade Earth Science

I. ORIGIN OF THE EARTH

8-1. ***The origin of the solar system is unknown, but there are several commonly accepted theories regarding its origin.***

ACTIVITY:

Materials: films
filmstrips
textbooks

Discuss the following theories of the origin of the solar system and the earth:

- The Nebular Hypothesis of Laplace.
- The Planetesimal Hypothesis of T. C. Chamberlin and F. R. Moulton.
- The Tidal Theory of Sir James Jeans and Sir Harold Jeffreys.
- The "Protoplanet" Hypothesis of Von Weizacker and G. P. Kuiper.

II. THE EARTH IN SPACE

A. The Solar System

8-2. ***The orbits of planets are ellipses rather than circles.***

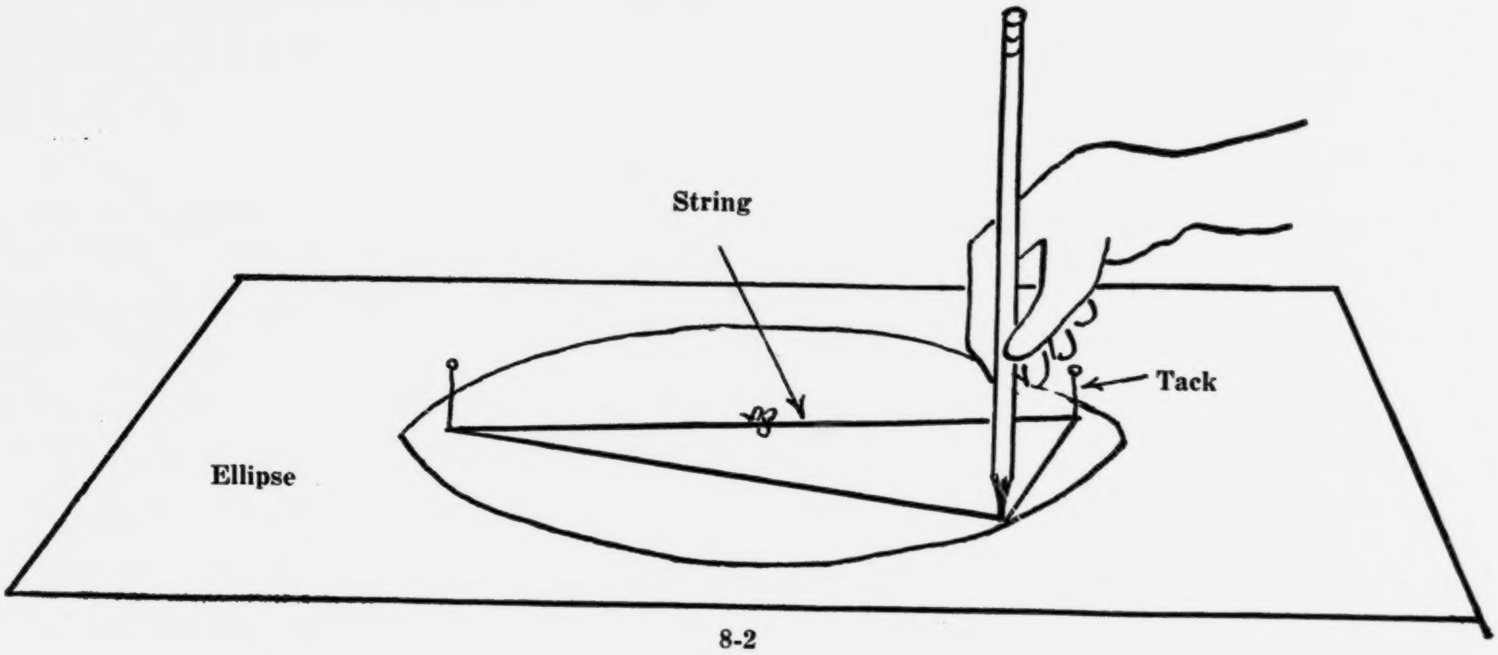
ACTIVITY:

Materials: a pencil
a piece of stiff cardboard
a loop of string
2 thumb tacks
drawing paper (minimum dimension 20 inches)

Place a sheet of drawing paper over the cardboard and push the two thumb tacks in the cardboard about 5 inches apart. Place a loose loop of string around the two tacks. Put the points of the pencil inside the loop and draw a circular figure keeping the string tight at all times. The figure drawn will be an ellipse. Try several others and observe what happens each time as the tacks are placed closer together. Students should conclude that the figure becomes more like a circle each time. Call attention to the following points:

- Each tack represents a focus of the ellipse; therefore, an ellipse has two foci, a circle has one.
- In the Solar System, the sun is located at one focus of the earth's orbit, but the foci are so close together that the orbit is almost a circle. If we take the greatest distance and the

smallest distance that a planet is from the sun, we can find the mean or average distance. The closest the earth comes to the sun is 91,500,000 miles. The farthest is 95,500,000 miles. What is the average distance?



8-2

8-3. ***Planets differ in distance from the sun.***

ACTIVITY A:

Materials: chart showing approximate distances of planets from the sun in millions of miles

Introduce to the students the meaning of the Astronomical Unit. The Astronomical Unit is used to compare distances from the sun to all the planets. The average distance from the earth to the sun equals 93,000,000 miles. This distance is called the A. U. (Astronomical Unit.)

ACTIVITY B:

Build a model of the Solar System to fit in the classroom. (The most distant planet can be no more than 20 ft. from the sun.) Pluto is about 40 Astronomical Units from the Sun. If we let 40 A.U. be represented by 20 feet, then one A.U. will be 6 inches on our scale. By working with the two extreme ends first, construct the model so that the earth is 6 inches from the sun and Pluto is 20 feet from the sun. Have students place the other planets in between at distances they figure out. Point out to the students that when drawings of the Solar System are put on paper, it is impossible to use the same scale for both distance and size.

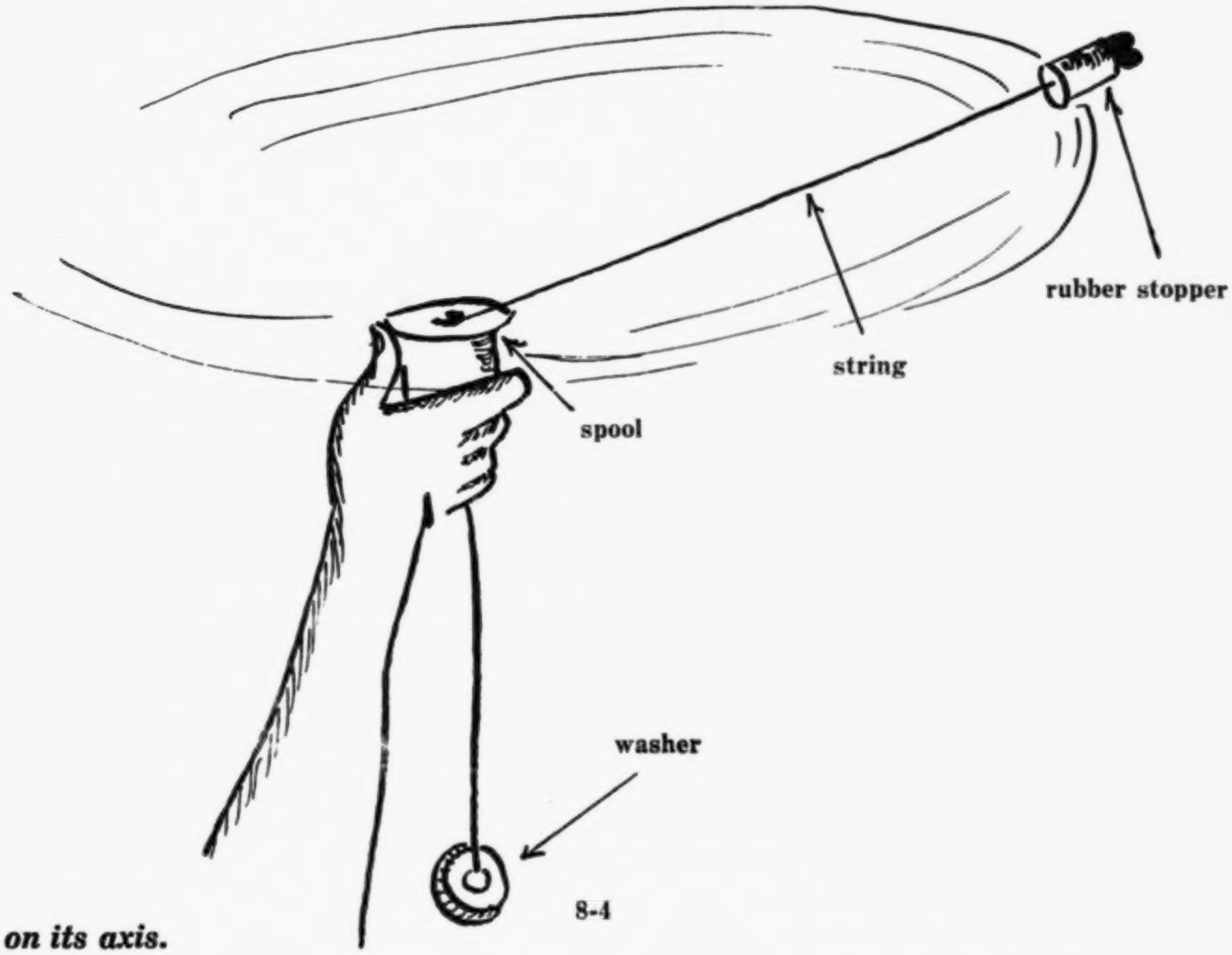
8-4. ***Gravity and inertia must be in balance in order for a planet or satellite to stay in orbit.***

ACTIVITY:

Materials: a piece of strong string about 5 feet long
3 or 4 heavy flat washers
a spool (or short length of glass tubing)
a rubber stopper (or some other heavy but soft object)

Pass the string through the spool, attach the washers to one end of the string and the stopper to the other (see illustration). Holding the spool above your head, twirl the stopper at proper speed so that the ball and weight balance each other. Let the string represent the force of gravity attracting the planet (stopper) to the sun (spool). Now twirl the stopper with greater force and observe that the stopper moves outward. As the demonstration is performed, raise the following questions: (1) What happens to the period of revolution of the stopper as the radius of the string becomes greater? As the radius of the string becomes less? (2) What would happen if the string were to break while revolving about your head? Why would this occur?

Relate this demonstration to Kepler's third law, the more distant a planet is from the sun, the slower it travels in orbit about the sun. Suggest a comparison with Newton's law of gravity: as the distance increases between objects, the gravity decreases, thus, the slower orbital speed. Point out one important difference between our analogy and planets in motion about the sun. There is a mechanical connection, the string, between your hand and the stopper you are twirling. There is no mechanical connection between the sun and the planets.



8-4

B. The Earth

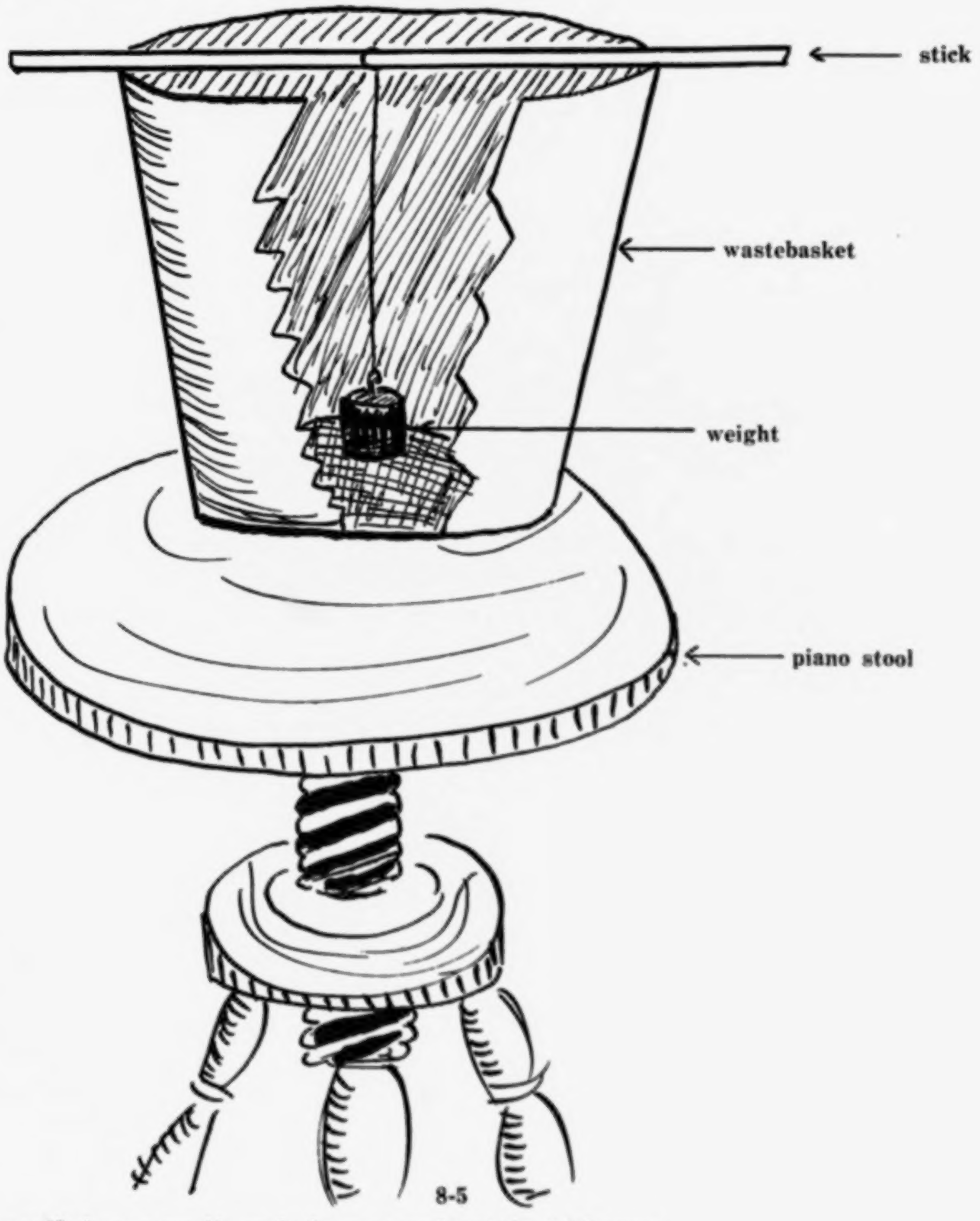
The earth rotates on its axis.

ACTIVITY:

Materials: rotating piano stool
wastebasket
stick
string
a small heavy weight

Place an empty wastebasket on the seat of a rotating piano stool. Tie a string to the weight and fasten the other end of the string to a stick long enough to fit across the top of the basket. Start the pendulum swinging, then rotate the stool seat along with the basket. Note that the path of the pendulum (swinging weight) does not change as the basket turns.

Some students may want to repeat the Foucault pendulum experiment on a larger scale after class under the direction of the teacher.



8-5

8-6. *The earth turns on its axis in approximately 24 hours.*

ACTIVITY:

Materials: globe
outline map of world
outline map of United States

Place a globe directly in front of you. Use the Greenwich meridian as a beginning point and make one complete rotation. Have the students investigate the following: Through how many degrees does the earth rotate in twenty-four hours? Through how many degrees does it turn in one hour? On the accompanying outline map of the world: Draw and label the international date line. Indicate the standard time of day in Los Angeles, California, when it is 11:00 a.m. in London, England.

8-7. ***The slow gyration of the earth's axis generates a cone. This precession takes place over 25,800 years.***

ACTIVITY:

Materials: several toy gyroscopes

Demonstrate precession of the gyroscope; then have students repeat this experience. Note that precession of the gyroscope will be in the opposite direction to the precession of the earth.

8-8. ***Day and night, and the four seasons of a year are caused by the earth's rotation on its axis and revolution in its orbit around the sun.***

ACTIVITY:

Materials: large globe
flashlight
film projector

Demonstrate, review, and explain the cause of night and day by rotating the globe in the path of the light.

Demonstrate, review, and explain the length of day and night at the North and South poles.

8-9. ***Latitude and longitude provide means of identifying one's position on the globe.***

ACTIVITY:

Materials: globe—6 or 12 inches in diameter

Observe the globe for latitude lines. How many degrees apart are the parallels on this globe? With the use of the globe, give the approximate north or south latitude of the following places: (Designate wide range of places.) Read from the globe the approximate east or west longitude of the following places: (Designate a wide range of places.)

C. The Moon

8-10. ***When satellites are compared to the planets around which they revolve, the earth's moon is relatively larger than the other satellites.***

ACTIVITY:

Materials: two balls, each of appropriate size.

Prepare a scale model of earth and moon, using a ball for the earth and a smaller ball of appropriate size for the moon. Calculate what the distance should be between the two in order to maintain the same scale as the sizes. The diameter of the smaller ball should be about one-fourth that of the larger ball. (A small globe may be used in place of the large ball.)

Since the earth's diameter is about 8000 miles, the moon's diameter about 2000 miles, and the moon is about 240,000 miles away, the distance between the earth and moon should be about 30 times the diameter of the ball representing the earth.

8-11. ***The moon is the earth's nearest neighbor.***

ACTIVITY:

Materials: telescope
a good photograph of the moon
clay

Arrange, if possible, a night session to give the students an opportunity to handle a telescope and to observe the moon. Upon return to class, have the students use clay or suitable materials and build models of the moon. Discuss its surface features, lack of atmosphere, and other physical features.

8-12. ***As the moon revolves around the earth, varying portions of its surface are seen.***

ACTIVITY:

Materials: slide projector
large white ball
darkened room

With the light shining full on the ball, have students view the ball from different directions. Direct them to see the crescent, quarter phases, gibbous and full.

Rearrange the demonstration by placing a group of students at one end of the classroom and the projector at the opposite end of the room. Hold the white ball in the beam of light and walk slowly around the group. The pupils will be able to see varying portions of the lighted surface.

8-13. ***The proximity of the moon to the earth results in eclipses of the sun and moon.***

ACTIVITY:

Materials: a slide projector
white ball
a darkened room
an earth globe

Place the white ball in the shadow of the earth globe to simulate a lunar eclipse. Place the white ball (moon) between the projector and the earth globe and its shadow will be cast on the globe. Show that an eclipse of the sun is not visible over as great an area as an eclipse of the moon.

8-14. ***The tides of the earth are primarily controlled by the gravitational attraction of the moon.***

ACTIVITY:

Explain the variations of tides (spring tide and neap tide). Emphasize that the highest tide is caused when the sun and moon are in line and pull together and that the lower tide is caused when the sun and moon are 90 degrees apart on the celestial sphere.

Look up predicted times of high tides if you are located near or on the coast. Keep a record of the tides and correlate these with the phases of the moon, remembering that there is a time lag.

Discuss the role of tides in causing currents that are locally important in eroding and depositing sediment. Point out that tides are the only demonstrated direct effect of the moon on our lives. Effects on weather and crops have not been proven.

D. The Sun

8-15. ***The sun is the center of the solar system and the source of almost all its energy.***

ACTIVITY:

Visit the Morehead Planetarium at Chapel Hill to see a model of the solar system, the position of the planets throughout the year, exhibits, astronomical instruments and to obtain information. Class visits may be scheduled by reservations.

8-16. ***Sunlight, when dispersed through a prism, forms a spectrum of colors.***

ACTIVITY:

Materials: slide projector
screen
triangular prism
card
sharp knife (or razor blade)
darkened room

Cut the card the size of a slide. In the center of the card cut a vertical slot ½ inch long and 1/16 inch wide. Insert the card into a slide holder and project on a screen or wall; it will appear as a bright vertical line. Hold the prism in front of the lens of the projector, with the refracting edge vertical. The light passing through the prism will be dispersed and will appear as a little spectrum with violet dispersed most, and red the least.

8-17. ***Sun time may be determined with accuracy.***

ACTIVITY:

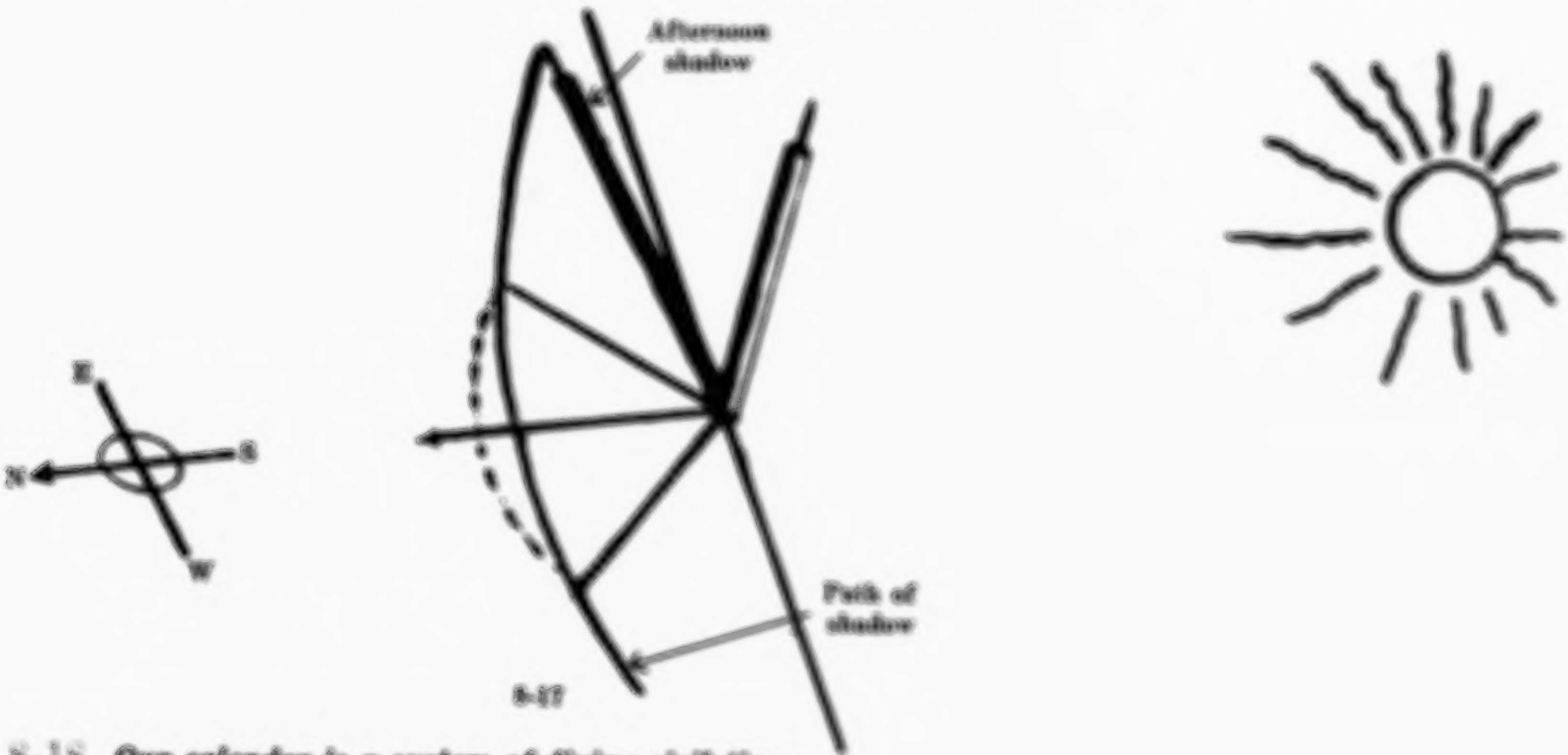
Materials: stick 4 or 5 feet long
stout piece of cord 20 or 30 feet long
several sticks

Sun time for any location can be determined with considerable accuracy with no more equipment than a stick 4 or 5 feet long and a stout piece of cord 20 or 30 feet long. Select a level area on the school grounds and drive the stick into the ground so that it is exactly vertical. Two or three hours before noon, tie the end of the cord to the base of the stick and measure the length of the shadow. Using this length as radius, draw an arc on the ground. Mark the point where the shadow touches the arc.

In the afternoon when the tip of the shadow just touches the arc again mark that point. Bisect this arc, using the two points as centers. Stretch the string from the original stick through the point bisecting the arc. This should be a true north-south line, a bit of the local meridian.

On the following day set a watch or alarm clock at 12 o'clock when the shadow of the stick is in line with the string. The timepiece will then be keeping sun time. Compare this with standard time on the schoolroom clock.

Drive stakes at the ends of the north-south line so that the ends are flush with the ground.



8-17

8-18. ***Our calendar is a system of fixing civil time.***

ACTIVITY:

To point out the history and development of the calendar, assign student reports on:

- The Aztec Calendar
- The Early Roman Calendar
- The Julian Calendar
- The Gregorian Calendar
- The World Calendar

E. The Stars, Constellations and Galaxies

8-19. ***Star trails show apparent rotation of the sky.***

ACTIVITY:

Materials: camera
film
tripod
watch or clock

Set camera focus for infinity, open diaphragm to full aperture, and set shutter for time exposure. Point the camera toward Polaris and start exposure. (Be sure that you are away from any local light source, i.e., street lights, etc.) Leave the camera undisturbed for two or more hours, then close the shutter for a minute or two, taking care not to disturb the camera. Open the shutter for a minute, then close it. This last short exposure (record the length of time for exposure) identifies the end of the exposure.

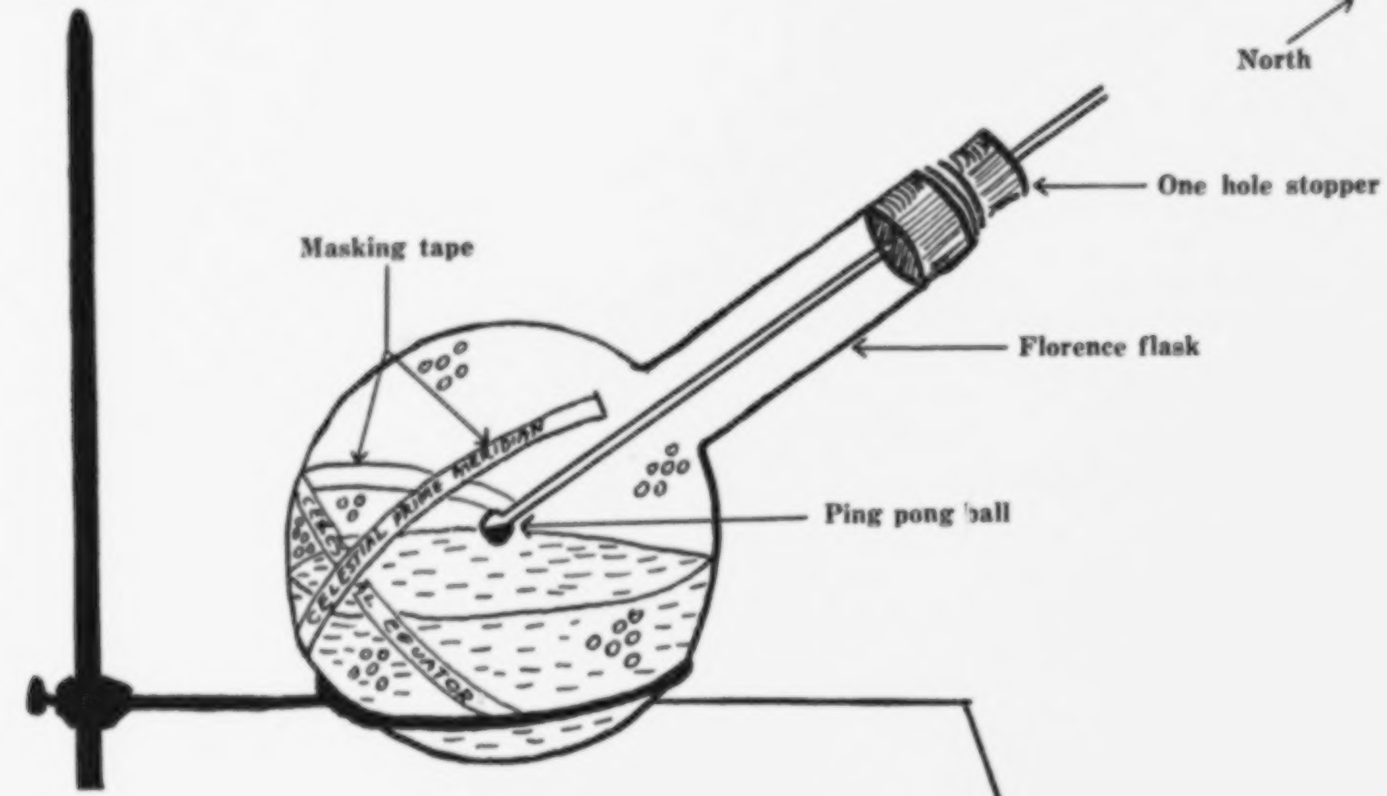
When the film is developed, it will show star trails as concentric arcs with centers near Polaris. The longer arcs can be measured to show the degrees of rotation.

8-20. ***Imaginary lines on the celestial sphere serve to locate celestial objects.***

ACTIVITY:

Materials: ringstand
florence flask
masking tape
wax pencil

Make a model of the celestial sphere. Fill a florence flask half full of ink-colored water (which will represent the horizon line). Fasten a small model of the earth (glass rod placed in a slit in a bi-colored ping pong ball or in a ball made of modeling clay) to the end of a glass rod. Use a one-hole rubber stopper to suspend the "Earth" in the colored water as shown in the illustration. Use strips of labeled masking tape to represent the celestial prime meridian and the celestial equator. (The celestial equator should be placed around the widest part of the flask and the celestial prime meridian is placed at right angles to equator.) Set the flask on the ring stand so that the polar axis points toward the north star. Use the wax pencil to locate the big dipper and other constellations on the upper part of the flask (above the horizon). Using the same technique, mark southern constellations below the horizon. (See illustration.)



8-20

8-21. ***Interest in the objects observed in the heavens extends back to earliest man. Many men have contributed to the history of astronomy.***

THE EARTH IN SPACE (ASTRONOMY)

A. The Solar System

B. The Earth (A Planet in Motion)
  (1) The Planet Earth
  (2) Location
  (3) Time
  (4) Maps and Map Reading

C. The Moon

D. The Sun

E. The Stars, Constellations, and Galaxies

Educational Media Resources

16mm Films and Filmclips
35mm Filmstrips
2" x 2" Slides and Flat Pictures
10" x 10" Transparencies
Charts, Graphs, Demonstration Devices, and Field Trips
Self-instructional Devices (8mm film loops - programed instruction)

THE EARTH IN SPACE (ASTRONOMY)

A. THE SOLAR SYSTEM

Objectives:

1. To provide a foundation for understanding the main theories concerning the origin of the earth and its companion planets.

2. To learn the physical arrangement of the various members of the solar system.

3. To become acquainted with the characteristics of the various planets and the lesser members of the solar system.

16mm Films

ASTEROIDS, COMETS, AND METEORITES. Film Assoc 11 min col/bw
Information on lesser members of the solar system. Good model photography illustrates principles of planetoids, comets, and meteorites. Up-to-date information.

CLOUDS OF VENUS. NASA 27 min col
Account of data gathered by Mariner II concerning surface features and temperatures and atmospheric depth and nature. Good example of how information is acquired by satellites.

MARS AND BEYOND. Disney 27 min col
Almost completely animated picture of early man's concepts of the planets and ancient explanations of the solar system. Gives principles of space travel. Presents theory of ion rocket. Speculates on various forms of life which have different bases than life on earth. Although it borders on science fiction, the creative approach should be welcomed as a very different one which junior high students can appreciate. Especially oriented toward Mars with portions taken at the Martian research observatory at Flagstaff, Arizona, established by Percival Lowell.

PLANETS IN ORBIT:THE LAWS OF KEPLER. EBF 10 min bw
Both a geocentric and heliocentric concept of the solar system is given as background for the work of Tycho Brahe and Kepler. The means of star position measurement by Brahe and the concepts of planetary motion of Kepler are illustrated. The work of Galileo on the telescope and Kepler's ideas for the improvement of this and other optical instruments is included. Good for the student who wants more than is found in most texts on Kepler's work.

SOLAR FAMILY. EBF 10 min col/bw
Presents the planetesimal hypothesis of the origin of the solar system. Excellent explanation of real and apparent movement of the planets with retrograde motion included. Illustrates the maximum angular arc of Mercury and Venus as measured from the sun. Orbits of comets are

shown. Orientation of our solar system in the Milky Way Galaxy. A 1947 film, but excellent.

SPACE SCIENCE:COMETS, METEORS, AND PLANETOIDS. Coronet 11 min col/bw

Film illustrates how comets, planetoids, and meteors are studied by use of radio telescope, and spectroscope. Reinforces the concept of the physical arrangement in the solar system of comets, meteors, and planetoids.

A TRIP TO THE PLANETS. EBF 15 min col/bw
Introduction of basic concepts of the solar system and of the forces which cause its motion. Develops ideas by animation and model photography. Includes relative sizes and distances from the sun for the planets, as well as the minor members of the solar system--comets, planetoids, and meteors. A good film for a simple beginning and refresher of previous work in astronomy by an imaginary visit through the solar system.

35mm Filmstrips

INTERESTING THINGS ABOUT THE PLANETS (SKY SERIES). Jam Handy 69 fr
Good general information on planetary size, temperature, periods of rotation and revolution, and moons. Used as device for addition reinforcement of solar system concepts.

MAN IN THE UNIVERSE (STORY OF UNIVERSE SERIES, Set IV). McGraw-Hill 46 fr col $7.50
Ideas of the possible numbers of solar systems and the chances of life in them is considered by this colorful filmstrip. Attempts are being made by radio to contact other intelligent life should it exist. A creative consideration of man as he may be found in the universe.

Flat Pictures

MARINER II - FLY-BY-FLIGHT TO VENUS. NASA
Production Aids for Television)
A deep space probe satellite is shown with its components which telemetered information of Venus's surface temperature and information on cosmic radiation and the impact of micrometeroids transpaque on space science vehicles.

THE SOLAR SYSTEM (Science Series 5820). EBF A set of 12 pictures made from photographs and charts.
On the back of each picture are suggested uses, explanation, questions, and related EBF materials.

10" x 10" Transparencies

THE UNIVERSE: SOLAR SYSTEM. Instructo
A transparency for overhead projection with two overlays--one of the inferior planets, one of the superior planets. Each overlay is color coded for identification. Shows natural satellites of the planets.

AT-1. The relatively eccentric orbit of a comet as compared with the orbits of the planets. (UNC, BAVE) col
The solar system: A Mercury, B Venus, C Earth, D Mars, E Asteroids, F Jupiter, H Uranus, I Neptune, and J Pluto.

Charts, Graphs, Demonstration Devices, and Field Trips

HAMMOND SPACE KIT. C. S. Hammond
A chart which is useful for showing solar system. Contains two dial charts with interesting information on densities, volumes, gravitation, and distance relationships. A quick reference aid to facts on data of the solar system. Useful for self-instruction.

FLANNELBOARD DISPLAY NO. 266 "The Solar System." Instructo
A helpful item to reinforce the concepts of the solar system for the slow learner through small group work. Useful as bulletin board material or for use by students as they report on the solar system. Applicable from the fourth grade through the junior high grades.

OUR SOLAR SYSTEMS. programed by Learning Incorporated for Coronet Films. Coronet
The booklet is a self-contained "teaching machine" consisting of two parts: a program presenting material to be learned and a mechanical answer panel inside each cover to aid in working the panel.

PROJECT PLANETARIUM (No. PP180). (Size 4" x 9") Hubbard
Working model of the Sun, Earth, and Moon designed for individual desk use.

HAMMOND'S SPACE INFOGRAPH. Hammond
Questions and answers on earth in space.

CLASSROOM SOLAR SYSTEM. Student Activity - Jerolene Nall
A model of our solar system may be made by students and extended across the side of the classroom.

The sun may be made of large sheets of construction paper showing its exterior physical characteristics. A wire is extended from the center of the sun to the opposite side of the classroom. The planets are made by taking balloons and inflating them to the desired size. Each balloon is then covered with a heavy coat of papier maché. Strips of brown wrapping paper about 1½ inches are cut. Flour is mixed with water and one at a time the strips are coated with the mixture and placed on the balloons layer by layer; this is allowed to dry overnight and a final layer to make a finished job is applied. After the planet is dry the surface is painted. The planets are suspended by a fine black wire from the wire which has been connected from wall to wall.

Self-Instructional Devices (8mm film loops - programed instruction)

AFL-1. The Earth's Shape. Film Assoc (3'28") col

Synopsis: Models are used to demonstrate that a lunar eclipse is caused by the moon moving into the earth's shadow. A telescopic time lapse motion picture of a lunar eclipse shows the advancing circular shadow of the earth. Finally, motion pictures taken from a high altitude rocket show the curve of the earth's surface.

Background Information:
This film shows two proofs that the earth is not round, but roughly spherical--a fact recognized as far back as 200 B.C. Actually, the earth is not truly spherical. Due to its rotation, it bulges at the equator, a fact first deduced by Newton in the early 1700's. Recent study of satellite orbits and more precise surface measurements show that the earth is somewhat pear-shaped, rather than a simple, flattened sphere.

An ancient proof of the earth's shape is that offered by a lunar eclipse. In a lunar eclipse, the moon moves into the earth's shadow. As it does so, we observe that the earth's shadow, thrown on the moon, is circular. Only objects with a circular shape can cast a circular shadow. Since the earth's shadow remains circular even though the earth itself is constantly turning, the earth must be a sphere.

Another proof of the earth's roundness has been made possible by modern technology. Pictures taken from high altitude rockets show the curve of the earth's surface. The white areas are clouds.

B. THE EARTH (A PLANET IN MOTION)

Objectives:

1. To become aware of the earth in its orbit around the sun and how this is related to the seasons.

2. To understand how the rotation of the earth on its axis is used to measure the passage of time.

3. To gain appreciation for the need and methods of accurate measurement of time.

4. To learn the existence of the earth's magnetic field and use of compasses.

5. To become familiar with the system of imaginary lines by which points on the earth's surface are actually located.

6. To gain an appreciation for the art of locating a position precisely on the earth's surface.

16mm Films

CAUSES OF THE SEASONS. Coronet 11 min bw

Presents the tilt of the earth's axis, the rotation on its axis, and revolution. Explains day and night. Clear diagrams.

Discusses the angle of the sun's rays and how it affects the climate in various sections on the globe. The seasons are discussed separately.

GLOBAL CONCEPTS IN MAPS. Coronet 11 min col

This is an excellent film to be used as an introduction to materials on map projections. Introduces cylindrical, conic, and perspective projections with a summary of practical application of each.

HOW DO WE KNOW THE EARTH MOVES? Film Assoc 11 min col/bw

This film demonstrates and explains the Foucault Pendulum, which first proved the earth's rotation.

Star shift illustrated which astronomers use to determine earth's solar orbit.

MAGNETIC FORCE. McGraw-Hill 27 min col/bw

Study of upper regions of our atmosphere and outer space. Man has launched several satellites and artificial planets to explore these regions which have given him a greater understanding of magnetic forces. Has demonstration and animations which are good.

35mm Filmstrips

THE EARTH AS A PLANET. McGraw-Hill (The Earth and Its Moon Series) 67 fr col

A study of the earth's composition and structure, presents the laws of gravity as a means of acquiring earth's mass.

EARTH'S MAGNETISM. Life Filmstrips (New Portrait of our Planet) 60 fr col

Earth's magnetic field and its behavior. Presents the influence of the moon on the earth. Introduction of Van Allen Radiation Belt; shows the Auroras.

THE EARTH'S SHAPE AND SIZE. McGraw-Hill (The Earth and Its Moons Series) 56 fr col

Presents astronomical principles which explain how we know the shape and size of the earth.

MOTIONS OF THE EARTH IN SPACE. McGraw-Hill (The Earth and Its Moons Series) 65 fr col

Explains how we know the earth rotates and revolves and the results of these motions.

10" x 10" Transparencies

The Earth (A Planet in Motion) - Twelve transparencies, UNC, BAVE col

Location

AT-2. Parallels of latitude are shown here at intervals of 15°. Meridians of longitude are shown here at intervals of 15°. Both east and west longitude meet at the 180° meridian...

Time

AT-3. Inclination of the axes of some of the planets.

AT-4. The inclination of the earth's axis is always in the same direction as it revolves around the sun.

AT-5. At the summer solstice the sun's vertical rays fall on the Tropic of Cancer.

AT-6. Seasonal variation in the period of daylight is shown in this view of the northern hemisphere.

AT-7. The distance from the earth to the sun varies because the earth's orbit is slightly elliptical.

AT-8. The standard time zones of the earth.

AT-9. Time Belts.

Maps and Map Reading

AT-10. A cylindrical map projection can be visualized as the result of wrapping.

AT-11. The principle of gnomonic map projection. Left, an actual map.

AT-12. The principle of conic map projection. (a) Simple conic projection.

AT-13. The principle of conic map projection. (b) Polyconic projection.

Charts, Graphs, Demonstration Devices, and Field Trips

Field Trip, MOREHEAD PLANETARIUM, CHAPEL HILL, NORTH CAROLINA
Astronomy orientation: celestial motions, planetary motions, constellation study.

Demonstration is paced by lecturer who also operates the planetarium.

Time: approximately one hour. Grade level: eight to adult
Cost: small admission fee Pre-arranged schedule.

Self-Instructional Device

LATITUDE AND LONGITUDE. (Coronet Learning Programs) Coronet
This booklet is a self-contained "teaching machine" consisting of ten sets on latitude and longitude, the last of which is a review.

THE EARTH IN SPACE (ASTRONOMY)

C. THE MOON

Objectives:

1. To identify the moon as a satellite of the earth.

2. To develop understanding of the physical nature of the moon as it is presently known.

3. To explain the changes in appearance of the moon as it moves through its orbit,.

4. To develop an appreciation for the role of the moon in producing the tides.

5. To show the moon's role in lunar and solar eclipses.

Procedure (developed by Genevieve Boucher)

With the moon so much in the news these days, the teacher finds her class already very interested in the subject and possessed of a real hodgepodge of information, some of which will be far-fetched. Her main job will be to capitalize on this interest while she sorts out and gets across the most basic and pertinent concepts.

Direct observation is very valuable both with a telescope or fieldglasses and with the naked eye. If the teacher can arrange one night session for this purpose, she should select a night around the time of the first quarter phase for at least two reasons: first, the surface features stand out much more clearly at this phase than at full moon because of the deep shadows formed by the sun's rays hitting the mountains and craters, etc., at an angle. At full moon phase the sun's rays fall straight onto the moon and it presents a much brighter but less interesting view. Second, if only one night session is possible, the teacher could combine a lunar observing session with a constellation-study session. In this case the first quarter phase would strike a happy medium, ideal for moon gazing and not too bright for star gazing. Of course, star viewing time is best when no moon is visible--and almost wasted motion at full moon when the moon reflects nine times more light than at first quarter.

Perhaps the most valuable viewing of the moon from the student's standpoint will be what he does with the naked eye at the same time each night over a two-week's period. The simple "Let's Chart the Moon" worksheet shown in this unit and easily duplicated by the teacher can be a very valuable teaching aid. Many concepts such as the following can be made clear by observation:

(a) True motion of the moon from west to east as it revolves around the earth.
(b) The length of time a revolution takes by observing that the moon has progressed from one horizon to the other (west to east) or half way around the earth in the two-week observation period.
(c) The time lag in moon's rising.
(d) Earthshine.
(e) Appearance, sequence, and reason for phases.

The teacher by use of the transparency, included here, can instruct the students on charting the moon. Each student, individually, at his own home and at a previously agreed upon time, will observe and then sketch the moon on his worksheet. Each day thereafter, during the two-week period, the teacher will do a brief follow-up, filling in her transparency as the students pool the results of their observation the night before.

All total or partial eclipses of the moon should be called to students' attention. Group observation is fine but not necessary. The total length of time involved in the lunar eclipse and the lack of need for any safety devices make observation very simple. Students might need to be reminded that the moon does not always have a coppery hue during eclipse as most textbooks suggest. For instance in the total eclipse of December 30, 1963, the moon seemingly disappeared, being one of the darkest in modern times, due to dust in the upper atmosphere from recent volcanic eruptions.

16mm Films and Filmclips

CELESTIAL MECHANICS AND LUNAR PROBE. NASA 12 min col
Mechanics of guiding lunar probes. Animation. Plane of moon, lines of node, precession, rotation of earth and moon on axes, revolution of moon around sun. Good for junior or senior high.

EXPLORING THE MOON. McGraw-Hill 16 min col
Nature of the moon's surface with possible origin of its features. Gravity, temperature, moon's surface, contrast between surface of

earth and moon. Wonderful moon shots; beautiful color. Imaginary space trip very effective.

THE MOON. EBF 10 min bw
Phases, months, eclipses, tides, sunrise and sunset on the moon, occultation of stars, and tidal lag. Old, but good.

TIDES OF THE OCEAN. Academy Films 16½ min bw
What the tides are and how the sun and moon cause them. Thorough explanation of tides based on Newton's Laws. Uses of ocean tides. Animated drawings also of other concepts such as why earth stays in orbit around the sun. Explains how gigantic forces of gravity and centrifugal force work together to cause tides, why there are daily two high and two low tides, why the highest tides occur when they do and why they vary with the seasons.

TRIP TO THE MOON. EBF 16 min col/bw
Explains the origin of craters and seas, shows why moon is a desolate and lifeless place; discusses gravitational attraction and physical features of the moon as a satellite of the earth. Excellent for objective 2 also. Junior and senior high.

16mm Filmclip

LUNAR SURFACE. NASA 38 sec Clip No. M-1
Close-up of lunar surface. Telescopic pan.

35mm Filmstrips

THE CHANGING MOON (SKY SERIES). Jam Handy 72 fr
The moon's changing appearance as seen from earth. Explanation of why the moon's shape changes. Explanation of eclipses and tides also given. Clear; up to date.

EARTH AND MOON (STORY OF THE UNIVERSE, SET I). McGraw-Hill 72 fr col
Summary of lunar information with actual moon photograph. Examines many lunar features. Good.

EARTH'S NEAREST NEIGHBOR. SVE 45 fr col
The moon's relationship to earth and its nature presented in an imaginary exploration on the moon. Measures needs of human body against moon conditions, prompts pupil reasoning about possible situations facing first human explorers.

2" x 2" Slides and Flat Pictures

LUNAR PHOTOGRAPHS. NASA
One Set of 8 x 10 glossy prints and one set of 17 black and white reprints of lunar photographs returned by Ranger VII spacecraft on July 31, 1964.

10" x 10" Transparencies

The Moon - Seven Transparencies, UNC, BAVI col

AT-14. The orbit of the moon is tilted with respect to the earth's orbit.

AT-15. The lower diagram shows that one half of the moon is always lighted as the moon revolves around the earth. Above, phases of moon as seen from earth.

AT-16. The Moon.

AT-17. One, eclipse of the moon. Two, an eclipse of the sun.

AT-18. The moon's gravitational attraction raises tidal bulges on the earth.

AT-19. Spring tides occur when the gravitational forces of the sun and moon are in a straight line. Neap tides occur when the gravitational forces of the sun and moon are at right angles to each other.

AT-20. Let's Chart the Moon. (Copy of worksheet prepared by Genevieve Boucher and described below)

This transparency to be used with identical worksheets of students. Teacher will use transparency to instruct on use of worksheet and to follow through on evaluation. Students using worksheets will sketch the moon nightly for a two-week period showing phases and positions of moon in sky. Beginning with young crescent and following through to full moon, students will observe and sketch how the moon actually revolves around the earth from west to east, that it moves about 13° each 24 hours, comparative brightness of first quarter with full moon, and earthshine, as well as many other facts concerning the moon and listed with the transparency.

Charts, Graphs, Demonstration Devices, and Field Trips

LUNAR EARTHSIDE HEMISPHERE (LEM-1). 2nd edition, November 1962, published by the Aeronautical Chart and Information Center, United States Air Force, St. Louis 18, Mo. Available from Superintendent of Documents, GPO $1

The photographs in the mosaicked image of the moon were selected from photographs taken at McDonald, Mt. Wilson and Pic du Midi Observatories. Graphic data edited by Dr. Gerard P. Kuiper, 1960.

FLANNEL BOARD DISPLAY ON MOON. C. S. Hammond (Instructo No. 265) $2.95 Introduction to study of moon, phases, penumbra, umbra, and eclipses. Very effective.

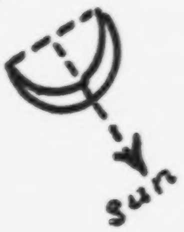
LET'S CHART THE MOON--WORKSHEET PATTERN. Original, Genevieve Boucher Pattern of worksheet can be easily duplicated and distributed to each student. Sky from west, through south, the east is marked off in 15° segments. Students observe and sketch moon at their respective homes at the same time nightly for about two weeks. The waxing moon is shown from young crescent through full moon with students instructed how to record the position and phase accurately. At the end of the two week charting period the students should have visual records proving the moon revolves half way around the earth in that time, that it revolves from west to east, that it moves about 13° each 24 hours, that it progressively turns more of its lighted portion to the earth as it goes from young crescent to full moon. Students enjoy this activity and learn a great deal from it.

Expected results of moon observations made about 7 P.M. on successive nights for about two weeks:

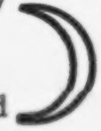
1. About one week after the new moon phase, the first quarter will be high in the southern sky, having risen about 6 hours earlier.

2. One week later, or about two weeks after new moon, the full moon will be low in the east, just coming up.

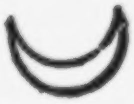
3. The cusps, or horns, of the moon will always be pointed away from the sun. You can locate the position of the sun by imagining a line drawn through the tips of the crescent, with a perpendicular from this, passing through the middle of the crescent. It will point straight toward the sun.



4. The tilt of the crescent varies. Around the autumnal equinox (September 23), the thin young crescent will be seen near the horizon and is tilted so that a line joining the tips of the horns is nearly upright to the horizon. This is what people may call a "dry moon" since obviously it could not "hold water."



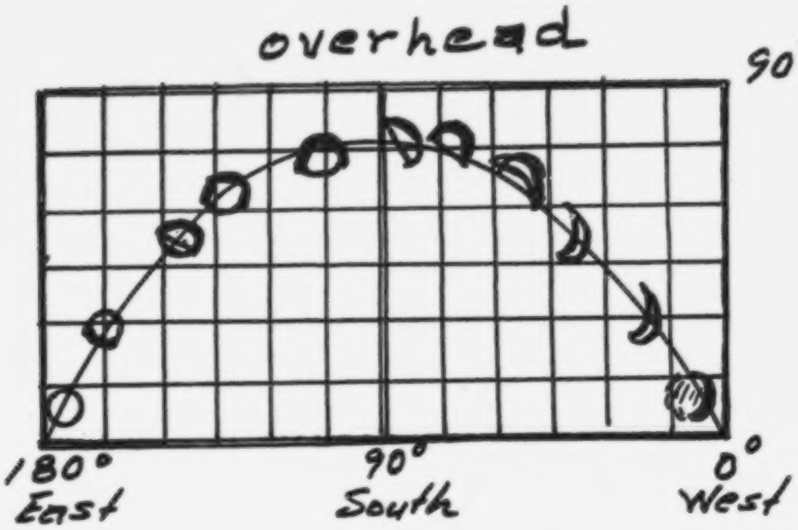
   In the spring the crescent of the young moon is sometimes called a "wet moon" since it looks as if it could hold water like a bowl. The young crescent will then be higher in the sky and almost directly over the place where the sun went down.



5. Surface features are much more prominent on the moon around first quarter than at full moon. At first quarter the sun's rays appear to us to be striking the moon at an angle, causing a three dimensional effect due to shadows formed by the peaks, valleys, craters, etc. There are none of these shadows at full moon time and the result is much less interesting.

6. Note the moon continues to wax from the young crescent phase to the full moon.

7. Results of moon observations may appear something like this:



Let's Chart the Moon!

Concepts:

1. The moon revolves around the earth in about one month. In two weeks time it will have traveled about half the distance or about 180 degrees.

2. The moon travels from west to east around the earth, moving about 13 degrees each 24 hours.

3. This true motion of the moon can be observed by viewing the moon at the same time each night. At the end of each twenty-four hour period it will be approximately 13 degrees farther east. (This is the average number of degrees only. The moon revolves faster when closer the earth and slower as it gets farther out.)

4. Since the earth rotates at a much faster rate than the moon revolves, the moon always appears to rise in the east and set in the west.

5. The moon rises about 50 minutes later each night. Since the moon will have moved about 13 degrees on to the east while the earth is rotating once, the earth will have to continue to rotate about 50 minutes longer in order to "catch up". Note the progressively later times of rising and setting in this two-weeks period:

   new moon (not visible)--rises with sun and sets with the sun.

   young crescent--rises just after sunrise and sets just after sunrise.

   first quarter--rises about mid-day and sets about midnight.

   full moon--rises about sunset and sets about sunrise.

6. At young crescent (and also at the old crescent phase if you are up early enough in the morning) earthshine is visible. This is a reflection of light from the day side of the earth upon the night side of the moon.

Procedure:

1. Sketch the moon nightly for about thirteen days.

2. Begin about one night after the new moon when the young crescent phase is just setting in the west. It will have been in the sky all day long but will not have been visible till after the sun has gone below the horizon.

3. Each student should observe at the same time he observed the night before, keeping this same time for the whole period. It is not necessary for the class to observe from the same place but the group should observe at the same time, if possible, for the sake of comparison.

(See Basic Moon Chart on following page.)

Self-Instructional Devices (8mm Film Loops - Programed Instruction)

AFL-2. Eclipse of the Moon. Film Assoc (3'38") col

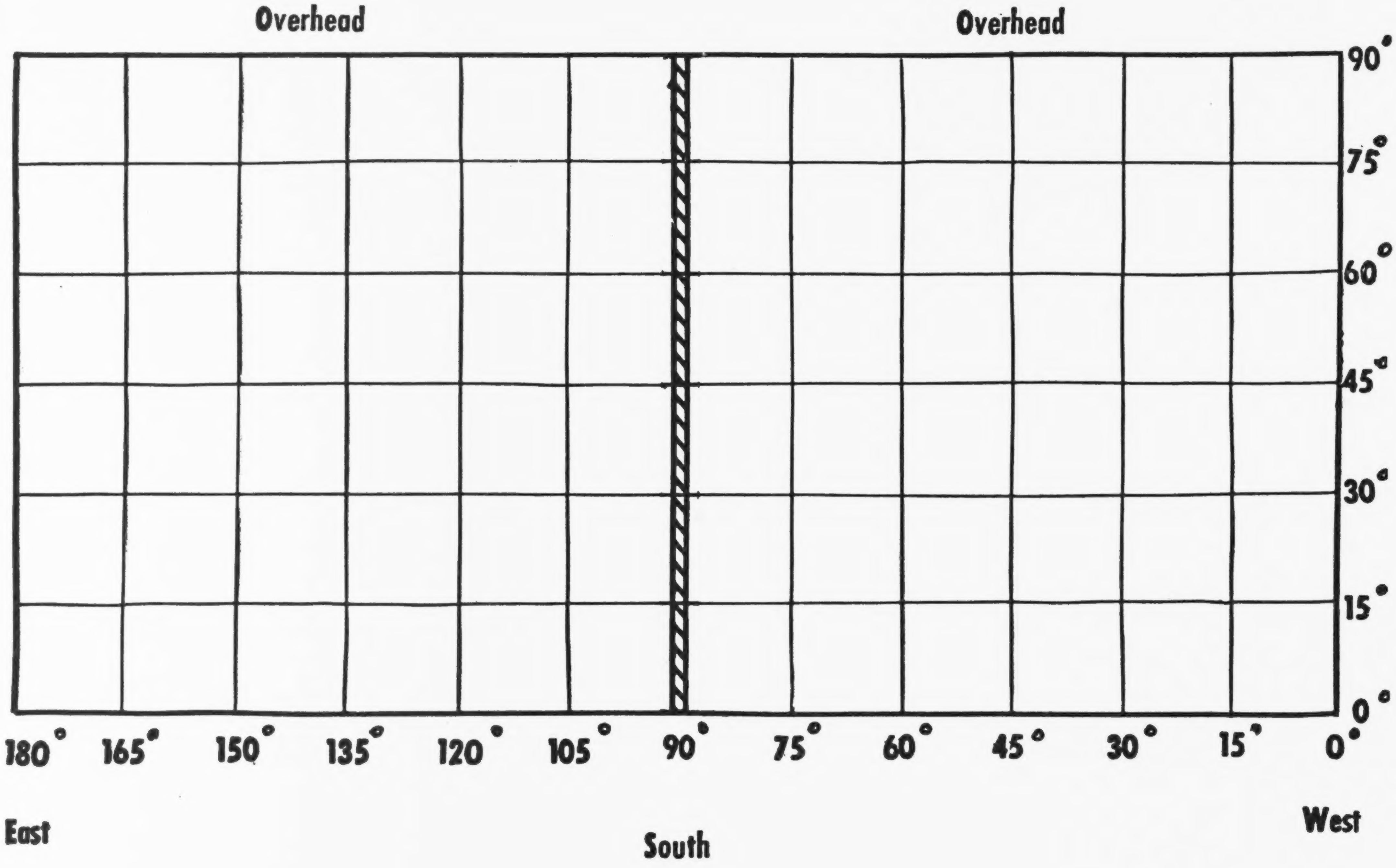
Synopsis: Animated models are used to demonstrate how the motion of the moon may carry it into the earth's shadow, producing a lunar eclipse. An actual lunar eclipse is shown in telescopic time-lapse motion pictures. Animation is then used to explain how the tilt of the moon's orbit is responsible for the intervals between eclipses, both solar and lunar.

Background Information: As the moon travels around the earth, its orbit sometimes carries it through the earth's shadow, causing an eclipse of the moon, a lunar eclipse. Such an eclipse is shown here in an actual motion picture of the event, but at 67 times normal speed.

The moon travels completely around the earth once every month. Then why doesn't it enter the earth's shadow every month, causing monthly lunar eclipses? The answer lies in the tilt of the moon's orbit in relation to the plane of the earth's orbit around the sun. In one trip around the earth, the moon must pass through the earth-sun plane twice. But an eclipse occurs only if the moon, on its passage through the earth-sun plane, is in a nearly direct line with the earth and sun, its shadow will fall on the earth and a solar eclipse will result. If it is directly behind the earth, it will be in the earth's shadow, and an eclipse of the moon will result.

As the earth and moon make their yearly orbit around the sun, the direction of the moon's tilt remains almost unchanged. During most of the year, the moon's shadow does not fall on the earth, and the moon itself passes north or south (above or below) the earth's shadow.

Let's Chart the Moon!



Because of the tilt, only during two months of the year can earth, moon, and sun fall into line. These periods, about six months apart, are called "eclipse seasons."

In time, however, the direction in which the moon's orbit is tilted does gradually change, so that eclipses do not occur at the same time every year. In a period of 18.6 years, the line of intersection between the orbits of the moon and earth rotates once completely. Thus, at intervals of 18.6 years, the eclipse seasons occur at the same calendar dates.

D. THE SUN

Objectives:

1. To know the basic structural features of the sun as an example of a characteristic type of star.
2. To gain some understanding of the source of the sun's enormous supply of energy.
3. To show how some of the events taking place on the sun are directly experienced on earth.
4. To learn how the sun's energy is being transformed into electricity.

Major ideas of the complex influence of the sun upon life on earth and its effect on the earth's magnetic field and upper atmosphere by solar flares can be explained with the following educational media.

The Bell Telephone film, OUR MR. SUN, is well done and arouses student interest and motivation. Transparencies of the sun's layers and features as sunspots and flares are useful to reinforce reference reading. PORTRAIT OF THE SUN gives much detailed information on thermonuclear reactions accounting for the sun's energy.

The sun is representative of a medium star. The reaction of hydrogen to form helium by fusion is an important concept which can be explained with transparencies.

The auroras are representative of how particples thrown from the sun may be trapped by the earth's magnetic field to give displays of the Northern Lights.

Spacecrafts need a continuous source of electrical energy. This is supplied by the solar battery. A new device which will be used more in the future is the solar cell.

16mm Films

OUR MR. SUN. Bell Tel 60 min col
Excellent as a broad view of the sun's importance, how it supplies energy, and how the sun is studied by coronagraphs and special filtered pictures in solar cameras. Solar flares and how these relate to earth communication are illustrated. Effect of flares on the earth's magnetic field by solar winds is studied. This is best for introduction, but could serve to culminate the study as well.

PORTRAIT OF THE SUN. Academy Films 18 min col
This film gives information in detail on size, mass, sunspots, prominences and eclipses of the sun. Seasonal changes caused by earth's revolution. Excellent film for explanation of major solar concepts.

BELL SOLAR BATTERY. Bell Tel 18 min col
Useful as information on new application to acquiring electricity from radiant energy. Contains how solar cells are manufactured. Gives advantages of solar batteries. Technical information is given but does not distract from main idea. Especially important for the use of solar cells in supplying energy for our satellites.

ECLIPSE OF THE QUIET SUN. Douglas Aircraft 28 min col
Total eclipse of 1963 as viewed from a transport plane especially equipped as an astronomical flying laboratory. Advantages of flying lab over ground lab. Discussion of how nature of sun is best studied during an eclipse. Solar storms; sun's strata. Beautiful photography. Teacher should explain time-lapse photography and should stress safety factors in viewing eclipses. Film neglected explanation of both. For instance, use old negatives through which to view eclipse was shown in film, but health authorities frown on this practice.

THE FLAMING SKY (PLANET EARTH SERIES). McGraw-Hill 27 min col/bw
This is a film of the auroras and how they are studied. Time-lapse photography serves to illustrate the movement of the auroras. The trapping effect of the earth's magnetic field is shown. Gives the study of auroras during the International Geophysical Year. Rocket research of high altitude magnetic fields by inducing man-made auroras.

16mm Filmclips

G-1 ORBITING SOLAR OBSERVATORY (OSO). NASA 2'35" bw
Study of "streetcar" satellite carrying various experiments to gather solar data above the earth's atmosphere. No sound, but printed narration is included.

N-1 SOLAR FLARE. NASA 2'48" bw
A sequence of solar eruptions being emitted from the sun's surface.

35mm Filmstrips

SUN'S AWESOME IMPACT (New Portrait of Our Planet, Part VII). Life Filmstrips col

2" x 2" Slides and Flat Pictures

ORBITING SOLAR OBSERVATORY. (NASA)
This is a photograph of the orbiting Solar Observatory (OSO) which gathers data on the sun not obtainable on the earth because of the screening out by the earth's atmosphere.

SOLAR FLARE. (NASA) bw
Illustrates a solar flare with the earth's relative size shown.

10" x 10" Transparencies

The Sun - Four transparencies, UNC, BAVE col

AT-21. Sunflare.

AT-22. Sunflares.

AT-23. This series of thermonuclear reactions probably furnishes most of the sun's energy.

AT-24. These hydrogen-helium reactions may furnish part of the sun's energy.

Self-Instructional Devices (8mm Film Loops - Programed Instruction)

AFL-3. Eclipse of the Sun. Film Assoc (3'29") col
Synopsis: Animated models are used to demonstrate how the motion of the moon around the earth can position it between the earth and sun. A telescopic motion picture of an eclipse of the sun is then shown. Additional features of the sun, visible during eclipses, complete the film.

Background Information: It sometimes happens that the moon's orbit carries it directly between the earth and sun. Then a shadow of the moon falls on the earth's surface. Note that towards the end of its path across the surface, the shadow becomes elliptical and its speed relative to the ground, increases.

When observed from a point within the eclipse path, the sun appears to be slowly covered by the moon. These are actual motion pictures of the eclipse of July 20, 1963, three hours condensed into about two minutes. At totality, the sun's outer atmosphere, called the "corona," and the "chromosphere", (the layer closer to the sun's edge) are visible. In the corona, we can see solar prominences.

Solar eclipses are of value in measuring the motions of sun and moon and in determining the nature and composition of corona and chromosphere. They have also been used to test the general theory of relativity.

(Note: The reason for the intervals between eclipses is explained in Earth Science Loop, AFL-2. Eclipse of the Moon.)

AFL-4. Solar Prominences. Film Assoc (2'54") col

Synopsis: This loop contains time-lapse telescopic motion pictures of solar prominences. The photography was done at the High Altitude Observatory in Boulder, Colorado.

Background Information: The cause of solar prominences is unknown, but it is known that they are associated with sun spots and "disturbed" regions on the sun. It is thought that magnetic fields in the solar corona (the sun's tenuous outer atmosphere) plan a role in the shapes of prominences. The motions within prominences are complicated. Material seems to condense out of the corona, and often rains downward into the lower chromospheric levels of the sun's atmosphere, possibly along magnetic lines of force. Some prominences, called "quiescent" prominences, may remain motionless for hours or even days. Others suddenly surge upward at speeds of up to 450 miles per second. Prominences may reach heights of hundreds of thousands of miles, many times the diameter of the earth.

E. THE STARS, CONSTELLATIONS, AND GALAXIES

Objectives:

1. To gain some understanding of the methods by which the distant objects in the universe may be investigated.
2. To develop awareness of the kinds of objects which are known to exist in the universe.
3. To provide a basis for appreciation of the dynamic processes operating to change the universe continuously.

16mm Films

THE ASTRONOMER. IntFlmBur 16 min col

Work of astronomers by use of instruments to study features of the universe, photography of stars, and nebulae. Use of radio telescope for study of distances, size, and shape of members of the universe.

BEYOND OUR SOLAR SYSTEM. Coronet 11 min bw

Presents basic information about stars--variation in size, color and temperature and their distances from each other. It examines and discusses constellations, nebulae, star clusters, the milky way and other galaxies and their position in the universe. The film progresses from most immediate to most distant, enabling student to orient himself and the earth in relation to the stars with which he is becoming acquainted.

Star trails made by circumpolar constellation around the North Pole shows movement of stars.

FRONTIERS IN SPACE. EBF 11 min col/bw
The film shows various ways in which astronomers obtain and analyze information about objects in space. It shows that nearly all we know about the stars comes from radiant energy--such as light, heat, and radio waves--that reach earth. The two major instruments used by astronomers are refracting and reflecting telescopes. The largest telescopes in world are shown (Hale telescope, Palomar Observatory). The spectroscope which enables the astronomer to determine composition of stars is discussed and whether they are moving toward earth. The radio telescope is introduced.

HOW MANY STARS?. Moody 11 min col/bw
Concept of time and distance discussed. The relative size of stars and number of stars are included in the film.

Presentation of the modern concept of the number of stars in space begins with a consideration of the sun and its family, the solar system. An imaginary trip is made to Alpha Centauri at the speed of light in order to clarify the meaning of a light year. Our galaxy is described and the solar system's place in the galaxy is established.

The probable number of stars within range of our largest telescope is estimated and illustrated in easy to understand way. Spiritual aspect is introduced briefly.

HOW VAST IS SPACE?. Atlantis 18 min col
Basic concepts concerning structure and geography of space from stars to atoms are discussed. Inner view of space, cosmic view, proportion and scale used in film. Based on pamphlet, "How Vast is Space."

MILKY WAY. United World 14 min col
How the sun's fusion processes work. Birth and death of stars, cosmic view of universe. Instruments used in exploring the heavens. General discussion of our night sky. Changes which a star is believed to undergo as a result of increasing temperature and pressure, hydrogen changes into helium at a rapidly increasing rate, the temperature falls, star contracts, as the light dies the star cools and becomes a dark mass moving through space. Points out that this is one of the theories concerning life cycle of a star. Presents good description of Milky Way. The theory of the expanding universe.

OUTER SPACE. Cenco 13 min col/bw
Presents the measuring of time distance and temperature of stars. Star variation in color according to temperature, star groups, nebular, galaxies.

STRANGE CASE OF COSMIC RAYS. Bell Telephone 60 min bw
Presents a scientific study of cosmic rays and the determination of their properties. Historical study of the atom and hypothesis of how cosmic rays originate. Presented on two reels so may be used two days due to length.

THE UNIVERSE. NASA 28 min bw
Gives a good general introduction to the study of astronomy. Discusses moon, planets, galaxies, lesser member of solar system. Binary stars.

WHAT ARE STARS MADE OF?. IntFlmBur 18 min col
Studies of globular clusters of stars. Chemistry of stars, using Hale telescope. Presentation of how conclusions are drawn and verified as to star composition and history.

WHAT IS SPACE. EBF 11 min col/bw
Shows simple experiments demonstrating that space is everywhere and the general simple properties of space. Introduction to our neighbors in space and our position in relation to them.

35mm Filmstrips

ABNORMAL STARS. McGraw-Hill 33 fr col
Presents normal stars, rare, but important unusual cases such as flaring, pulsating, shedding and exploding stars.

BETWEEN THE STARS. McGraw-Hill 50 fr col
Discusses the interstellar dust with good general information on that which lies between the stars, the changing nature of the stars and the causes.

EYES AND EARS. McGraw-Hill 48 fr col
Uses of optical telescopes, functioning of radio telescope. Astronomical instruments and planning stages.

HOW FAR ARE THE STARS?. McGraw-Hill 48 fr col
Familar methods of measuring the distances of stars and the distances between them.

HOW WE LEARN ABOUT THE SKY. Jam Handy 52 fr col
Early explorers of space shown; mechanics of our large telescopes; includes sketches of constellations.

THE LIFE OF A STAR. McGraw-Hill 50 fr col
Presents a broad, general description of our knowledge of the stars, recent pictures of the stars, how they evolve and the birth and death of stars.

MILKY WAY. McGraw-Hill 43 fr col
Typical galaxy presented with emphasis on our galaxy. How the study of the galaxies is done.

MORE ABOUT THE STARS. McGraw-Hill 48 fr col
Presents star temperatures, true brightness, size, mass, density, and discusses the more important stars.

THE UNIVERSE. McGraw-Hill 50 fr col
Overall general introduction to the study of the northern star system. Discussion of circumpolar constellations and varying magnitudes of stars.

WHY THE STARS?. McGraw-Hill 51 fr col
Physical nature of stars, composition and energy.

2" x 2" Slides and Flat Pictures

Colored photographs of the following nebulae: Northrop

Crab Nebula in Taurus
Trifid Nebula in Sagittarius
Dumb-bell Nebula Vulpecula
Great Galaxy of Andromeda

The above are large, color photographs of the nebulae suitable for wall display.

10" x 10" Transparencies

The Stars, Constellations and Galaxies - Six transparencies, UNC, BAVE col

AT-25. Because the earth revolves around the sun, the appearance of the night sky changes with the seasons.

AT-26. A comparison of the actual sizes of some well-known stars.

AT-27. A drawing showing the probable appearance of our own Galaxy. Arrow indicates position of solar system.

AT-28. Winter sky evening, facing north.

AT-29. Winter sky evening, facing south.

AT-30. Telescope.

Charts, Graphs, Demonstration Devices, and Field Trips

CHALK MARKABLE STAR CHART (NORTHERN SKY). Hubbard

DESK OUTLINE STAR CHARTS. Hubbard 50/pkg

LUMINOUS STAR FINDER. Hubbard

Small chart which has movable disc showing stars as they appear at various times during the year. The major stars are luminous. Good for individual use.

CIRCUMPOLAR BOARD

Round 48" plywood board painted dark blue with 5 circumpolar constellations superimposed and mounted for wall display. Relative position of constellations and star magnitudes. Board rotates on screw through Polaris. Used to demonstrate to students that earth appears to rotate around Polaris. Shows how these five constellations pivot around Polaris in 24 hour period. Relates position of circumpolars for each month of season.

Self-Instructional Devices (8mm loops - programmed instruction)

AFL-5. Mars and Jupiter. Film Assoc (3'38") col

Synopsis: Telescopic time-lapse motion pictures of Mars and Jupiter show their gross surface features. Rotation is observed, and a transit of one of Jupiter's moons.

Background Information: These time-lapse motion pictures were made with the 60" telescope on Mount Wilson. The south poles of the planets are shown at the top.

Mars is the only planet other than Mercury whose solid surface we can see. Rotation is seen; one rotation (one Martian day) requires twenty-four hours 37½ minutes. Mars' axis is tilted 25° to the Martian orbit, and therefore the planet has seasons. We observe these seasons in the advance and recession of white patches on either pole, and in color changes in other areas. Astronomers believe that the white polar caps are some form of frozen water. The color changes may be due to the growth and decay of vegetation. In winter, the southern polar cap is 3700 miles in diameter. The Martian year is 687 of our days long.

By taking advantage of brief clear spells in the atmospheres of Earth and Mars, too brief for a photograph, good observers can see more detail than can be photographed. Some observers claim to have seen fine, straight lines (the so-called "canals") on the surface of Mars, but these have never been verified, and the existence of true canals is now generally discredited.

Jupiter is the fifth planet from the sun. It is the largest planet, much larger than earth. Its mass is 318 times as great as earth's; its radius 11 times as great; its force of gravity 2.64 times as strong. Its rapid rotation--about every ten hours--has noticeably flattened it at the poles. We can see only the top of Jupiter's atmosphere, gases about -220°F. The white bands are believed to be gases moving upward and containing crystals of frozen ammonia. The dark bands may be gases moving downwards.

Jupiter has twelve moons. The two largest are 1½ times the size of the earth's moon. The passage of one of these moons (and its shadow) across the planet is seen at the end of the film.

AFL-6. Comet Orbits. Film Assoc (3'11") col

Synopsis: Animation is used to demonstrate the unusual nature of comet orbits. Photographs of comets are also shown.

Background Information: Comets are members of the solar system, but at their aphelion (the point of their orbit which is farthest from the sun) they are generally too distant to be observed. We see them only when they approach the sun. As they do so, they develop thin tails which point generally away from the sun. Like other members of the solar system, comets travel in elliptical orbits. But the ellipses of their orbits are usually so elongated that the part we can observe resembles a parabola. Most members of the solar system have orbits inclined within a few degrees of the plane of the earth's orbit, or ecliptic. But the orbit of a comet may intersect this plane at any angle.

SPACE EXPLORATION

DEEP SPACE PROBES (72)

An artist's conception of the Mariner II fly-by flight to Venus. Launched August 27, 1962, Mariner II passed by Venus on December 14 at a distance of 21,648 miles. A new record was established when communications with Mariner II were maintained until it reached a distance of 53.9 million miles from earth. Mariner fed back such important information as the temperatures, magnetic fields and rotation of Venus, providing scientists with information hitherto unavailable. During its trip, Mariner II also provided valuable information on cosmic radiation and the impact of micrometeroids on space vehicles. Mariner II, after its fly-by of Venus, went into permanent orbit around the sun.

North Carolina State Department of Public Instruction Curriculum Bulletin

Suggested Principles and Activities for Eighth Grade Space Science

SPACE EXPLORATION

(Paragraphs 8-22 through 8-26)

ACTIVITY:

Direct interested students in reading and reporting about the contributions of:

Anaximander	611? B. C.	Ptolemy	90? -168? A.D.
Pythagoras of Samos	530? B. C.	Copernicus	1473-1543
Plato	437-347 B. C.	Brahe	1546-1601
Aristotle	384-322 B. C.	Kepler	1571-1630
Aristarchus of Samos	310-230 B. C.	Galileo	1564-1642
Eratosthenes	225 B. C.	Newton	1642-1727
Hiparchus	160?-125 B. C.		

III. SPACE EXPLORATION

8-22. ***Man has launched several satellites and artificial "planets" to explore the upper regions of our atmosphere and outer space.***

ACTIVITY:

Assign several students to do library research on the history and development of rocketry and report their projects to the class. Other students may be assigned specific topics on activities conducted during the International Geophysical Year.

8-23. ***A rocket is launched and kept in space by means of Newton's laws of motion and gravitation, and by Kepler's laws of motion of planetary bodies.***

ACTIVITY:

Discuss and review Newton's laws of motion, and Kepler's laws of planetary motion. Demonstrate Newton's third law with the use of a model of Hero's engine.

8-24. ***A satellite must reach an orbital velocity of approximately 18,000 miles per hour to go into orbit.***

ACTIVITY:

Prepare charts and bulletin boards to illustrate problems involved in launching a satellite from the earth and getting it into orbit. Point out the meaning of escape velocity and orbital velocity.

8-25. ***Each new launching of an instrumented or manned satellite has increased man's knowledge of his space environment.***

ACTIVITY:

Collect newspaper articles relating to some recent space exploits and discuss their implications to communications, National Defense, and health hazards of astronauts.

8-26. ***Space programs are now in preparation for landing a man on the moon.***

ACTIVITY:

Direct students in reading and reporting on publications, pamphlets and materials relating to space travel issued by: (1) the U. S. Office of Education (2) The National Aviation Council (3) The National Aeronautics and Space Administration.

IV. STRUCTURE AND COMPOSITION OF THE EARTH

A. Spheres of the Earth

8-27. ***The earth is divided into three major spheres (for convenience of study). Each sphere encompasses a major state of matter, i.e., lithosphere, the solid state; hydrosphere, the liquid state; and atmosphere, the gaseous state.***

ACTIVITY:

Materials: chalkboard or chart paper
colored chalk or colors suitable for chart paper

Prepare a chart or draw on the chalkboard a cross section drawing to illustrate from the center of the earth to the exosphere. Layers to be shown should include core, mantle, crust, troposphere, stratosphere, ozonosphere, ionosphere, exosphere. Textbooks contain diagrams that will serve as guides. Call to the attention of the pupils the discontinuous nature of the hydrosphere.

8-28. ***The earth (lithosphere) has a concentric layering of materials, with the densest materials at the center and successively lighter layers outward.***

ACTIVITY A:

Materials: modeling clay (3 colors)

Make a model of the earth's structure (lithosphere) using different colors. Show by cross section the core, mantle and crust.

ACTIVITY B:

Have students make a scale model of a cross section of the interior of the earth. Using a scale of 12″ = 8000 miles, they should be able to determine the relative thickness of each of the sections of the inner earth.

Relative Thickness of Layers of the Earth

Crust	25 miles	=	.04 inches
Mantle	1800 miles	=	2.7 inches
Outer Core	1300 miles	=	1.9 inches
Inner Core	900 miles	=	1.4 inches (To center)

If the students are familiar with ratio and proportions, have them use this method to compute the above scale. (The thickness of the crust would have to be represented by a thin pencil line.)

Example:

$$\frac{\text{diameter of earth (scale)}}{\text{diameter of earth}} = \frac{\text{thickness of section (scale)}}{\text{thickness of section of earth}}$$

Or as computed for mantle:

$$\frac{12}{8000} = \frac{N}{1800}$$

$$8000\ N = 12 \times 1800 \qquad \text{Cross multiplying}$$

$$8000\ N = 21{,}600$$

$$\frac{8000\ N}{8000} = \frac{21{,}600}{8000} \qquad \text{Dividing both sides by 8000}$$

$$N = 2.7 \text{ inches}$$

SPACE EXPLORATION

A. Space Travel

B. Rocketry and Space Vehicles

C. Man's Satellites

D. Moon Flight

Educational Media Resources

16mm Films and Clips
35mm Filmstrips
2" x 2" Slides and Flat Pictures
10" x 10" Transparencies
Charts, Graphs, Demonstration Devices, and Field Trips
Self-Instructional Devices (8mm film loops - programed instruction)

SPACE EXPLORATION

A. SPACE TRAVEL

Objectives:

1. To develop an appreciation for the history and progress of space travel.
2. To become acquainted with the biological and psychological problems involved in man's space flight.

16mm Films

WHY EXPLORE SPACE?. Dimension-Churchill 16 min col
Good introduction to space exploration. Documented Mercury flight of John Glenn. Thought provoking as to space research: weather, communications, transportation, health and medicine.

HOW WE EXPLORE SPACE. Film Assoc 16½ min col
Introduces the instruments astronomers use and the methods by which they obtain information about objects in space. Special instruments used with the telescope: spectroscope, cameras and photocell. Includes color motion pictures of the moon, Mars, Jupiter, Saturn and the sun.

PIONEERS IN SPACE. AssnFlms 28 min bw
Good introduction to space exploration. Includes Mercury flights of John Glenn and Scott Carpenter.

THE MASTERY OF SPACE. NASA 58 min col
Traces the development of Project Mercury. Projects Gemini, Apollo, and Saturn booster are briefly discussed.

JOHN GLENN SPEAKS TO YOUNG AMERICANS. NASA 11½ min col
America's famed astronaut addresses science fair winners and answers their questions about space exploration. John Glenn's message is a challenge to young people to prepare for important responsibilities in the space age.

AMERICA IN SPACE. NASA 14 min col
Overview of National Aeronautics and Space Administration space efforts. Explains programs from Explorer I through Apollo manned moon mission.

HOW MAN TRAVELS THROUGH SPACE. Cenco 12 min col/bw
This film describes how man is able to leave the earth and travel out into space. The principles of rocket propulsion and staging are explained; also, problems of launch, space travel and re-entry.

THE JOHN GLENN STORY. NASA 31 min col

The biography of John Glenn as a boy in New Concord, Ohio, Marine Corps pilot in World War II and the Korean War. His orbital flight is well documented.

RACE FOR SPACE. McGraw-Hill. 60 min bw

Documents the contest between the United States and Russia. Gives background of rocket development from 1899 to present day. Also shows the use of rockets during World War II by the Germans. Part II gives step by step the race to put vehicles and man into space.

SATURN: GIANT STEP TO THE MOON. NASA 15 min col

Film shows transportation, erection, and launching of the SA-1 Booster from launch complex #34 at Cape Kennedy.

TOWARD THE UNEXPLORED. McGraw-Hill 26 min bw

Documentary of the X-2 rocket airplane that took man higher and faster than he had flown before. A CBS 20th Century Production.

X-15 DOCUMENTARY. NASA 27 min col

Flight tests of X-15 in the research program conducted at Edwards Air Force Base.

SCIENCE IN SPACE (PLANET EARTH SERIES). McGraw-Hill 27 min col/bw

A very broad coverage of information. Includes Van Allen radiation belts, radio and optical methods of tracking satellites and the telemetry of data from satellites (variation of earth's mass and shape, micrometeorites, cloud cover, magnetic field, ultraviolet light, X-rays, and cosmic rays).

THE BIOSATELLITE PROGRAM: BETWEEN THE ATOM AND THE STAR. NASA - 1965 29 min col

To acquire more knowledge about the basic life processes and the ability of man to live under such space conditions as zero gravity and prolonged periods of confinement, NASA plans to conduct a variety of biological experiments. This film depicts some of the planned experiments in which animals react to space conditions.

THE FLIGHT OF FAITH 7. NASA 28½ min col

Gordon Cooper's flight in the Faith 7 spacecraft on 15-16 August 1963. Documented from initial pre-flight training and medical checkouts to scenes of the MA-9 launch, in flight, and recovery. Includes motion picture scenes made from color still photos taken of the earth by Cooper.

FRIENDSHIP 7. NASA 58 min col

Depicts the three orbital flights of John Glenn prior to and during actual flight, showing use of manual control and re-entry.

THE SHAPE OF THINGS TO COME. NASA - 1965 21 min col
Several areas of advanced research in the peaceful exploration of space are illustrated in this film, including research in microminiaturization, superconductivity, the M-2 "lifting body."

STEPS TO SATURN. NASA 22 min col
Shows development of the Saturn program and historic change from rocket weapon to rocket space vehicle. Includes Newton's Laws of Motion. Culminates in the flight of the first vehicle which is linked with the decision to set the manned moon flight as a national priority goal. Good for space terminology.

TRIAL BALANCE. NASA - 1965 27 min col
What have we learned from space exploration? In this film, NASA presents a comprehensive survey of the current state of knowledge in the area of space science, and how space exploration has changed some of our scientific concepts.

2" x 2" Slides and Flat Pictures

HISTORY OF U. S. SPACE EXPLORATION. NASA (2" x 2" slides)
These 2" x 2" slides introduce space explorations with the well-publicized Project Mercury. Satellites which have been launched prior to, during, and since Mercury show the various types of unmanned research vehicles. Project Gemini is introduced through a brief description of the Saturn Rocket and launch pad #37. Artist drawings of Project Gemini illustrate the mission of Gemini. Boiler plate and first flight models are shown at complex #19.

Project Apollo, manned flight to the moon, is illustrated with artist conceptions of the launch, lunar orbiting, landing, rendezvous, and return to earth of the Apollo space craft.

The seven original astronauts are introduced and several aspects of the training program are documented with pictures of jungle, desert, and water survival training and space flight simulators.

(Group C) Project Mercury, launch, recovery and earth pictures taken from space.

(Group E) Satellites and space probes; communication, weather, and scientific satellites.

(Group F) The Saturn Rocket and launch pad #37.

(Group B) Project Gemini, on the drawing boards, boiler plates, and first flight model at complex #19.

(Group A) Project Apollo, manned flight to the moon. Illustrated steps in man's moon flight and return to earth.

(Group D--31-36) Astronaut training, jungle, desert, and water survival. Space flight simulators.

8" x 10" glossy prints of Astronauts and Astronaut training. Available from NASA.

10" x 10" Transparencies

History of Space Travel - Two transparencies, UMC, BAVE col

ST-1. Two possible ways to escape from the earth.

ST-2. A possible satellite orbit to Venus.

Charts, Graphs, Demonstration Devices, and Field Trips

LAWS OF MOTION OF THE PLANETS AND SATELLITES--TNP-2. Denoyer
Chart made in Western Germany illustrating Newton's Third Law of Motion; it includes a rocket cross-section.

Objective — To become acquainted with the biological and psychological problems involved in man's space flight.

16mm Films

BALANCE OF LIFE AND THE SPACE AGE. Film Assoc 13½ min col/bw
Considers the earth's living things in terms of their basic needs. Considers the carbon dioxide-oxygen cycle for extended space flights.

FIRST MEN INTO SPACE. EBF 16 min col/bw
Explains the concepts of placing a man in space and bringing him back. Recreates the first American orbital space flight. Shows problems and how solutions were applied by engineers to the first space capsule project.

THE FOUR DAYS OF GEMINI 4. NASA - 1965 28 min col
The story of the Gemini-Titan 4 Mission, flown by Astronauts McDivitt and White, including the historical "walk in space" by Major White. The film dramatically illustrates a typical Gemini manned flight from pre-launch to recovery.

LIVING IN SPACE. Boeing 12½ min col
This film shows the environment, food and atmosphere in a space vehicle, and the physiological and psychological aspects of this environment. Discussion of instrumentation to measure and record man's reactions in space.

35mm Filmstrips

CONDITIONS IN SPACE. Jam Handy 38 fr col
Presents the hazards of space travel with a good discussion for Van Allen Belts.

MAN'S PREPARATION FOR SPACE. Jam Handy 38 fr col
The biological hazards involved in manned space flight travel are presented with excellent explanation of terminology.

HOW GRAVITY WORKS (WHY OF ELEMENTARY SCIENCE, Set of 11, No. 3).
Filmstrip House color
Earth's gravitational forces illustrated as related to inertia and weightlessness. Gravitational forces involved with lunar trip described.

2" x 2" Slides and Flat Pictures

NASA PRODUCTION AIDS FOR TV, Part 2--Still Photographs NASA bw
Photographs that can lead to a greater appreciation of biological problems involved in space travel. Nos. 1, 6, 14, 18, 30, 31.

Charts, Graphs, Demonstration Devices, and Field Trips

HIGH ALTITUDE BREATHING. (chart) National Aviation Counc
Prepared by Douglas Aircraft Co., this chart explains some physiological aspects of breathing at high altitudes without a pressure suit. Consequences of bailout or ejection at high altitudes depend on type of survival gear worn and its retention during descent. Discuss in connection with artificial atmosphere needed in space travel.

Self-Instructional Devices (8mm film loops - programmed instruction)

SFL-1. FREE FALL IN SPACE. Film Assoc (3'38") col
Why doesn't a satellite fall? The answer is that it is falling all the time. The force of inertia carries the satellite forward in a straight line, but, as it moves forward, the force of gravity pulls it toward the center of the earth. As a result of these two forces, the satellite moves in a curved path. If it is put into orbit with just the right speed for its altitude, its curved path will follow the curve of the earth. It will remain in orbit, both falling and travelling forward all the time. Inside the satellite, everything that is not fastened down--like the end of the strap--can float, weightless.

SFL-2. EXPERIMENTAL WEIGHTLESSNESS. Film Assoc (3'12") col
The earth's gravity pulls objects down with a force equal to an acceleration of 32 ft/sec. Any object accelerating toward the earth with this speed will be weightless. Many people have briefly experienced weightlessness riding in a roller coaster at the instant when

the car is moving downward with an acceleration of 32 ft/sec. The same effect is sometimes felt in elevators. Note that moving upwards and decelerating at 32 ft/sec is the equivalent of moving downwards and accelerating at 32 ft/sec.

Since astronauts are weightless in space, scientists who wish to study the effects of weightlessness have tried to devise ways of producing it for prolonged periods. Some of these experiments are shown here. The flight path of the plane is carefully planned. During its climb, the speed with which the plane is moving upward is slowing down at the rate of 32 ft/sec; during its dive, its rate of descent is accelerating at a rate of 32 ft/sec. In other words, the plane maintains a constant downward acceleration of 32 ft/sec---equivalent to the force of gravity. The plane and everything in in are weightless. The people inside perform experiments to discover the difficulties astronauts have in working, moving, and even eating.

SPACE EXPLORATION

B. ROCKETRY AND SPACE VEHICLES

Objective: To become acquainted with the physical principles which make the rocket the only practicable space vehicle.

16mm Films

FATHER OF THE SPACE AGE. NASA 18 min bw
Historical. Documents the development of Dr. Goddard's research on rocketry. Original motion pictures of Dr. Goddard's rocket tests.

ROCKETS: PRINCIPLES AND SAFETY. Film Assoc 11 min col/bw
Introduces the physical principles upon which rockets work. Explains why rocket motors can work in the absence of air (outer space). It stresses the fact that rockets are dangerous and should not be built or fired by amateurs.

ROCKETS AND SATELLITES. United World Flms 13½ min col
From countdown to the exciting blastoff and space probe. Complex concepts are clarified as to types of flight, rocket stages, Newton's Third Law of Motion, and establishing orbits. Good summary. Also useful for study of behavior and purpose of artificial earth satellites.

RESEARCH BY ROCKETS. McGraw-Hill 27 min col/bw
The exploration of the upper atmosphere by instruments carried aloft by rockets is shown. The history of man's attempts to reach out into space by modern rocket vehicles is examined and the principles of rocket operation are explained. Significant discoveries relating to the atmosphere, ionosphere, the earth's magnetic field, cosmic rays, the aurora, and radiations from the sun are examined.

MOLECULES TO MISSILES. Redstone 10½ min col
This film depicts propellant research and production. Research includes search, inquiry and investigation. Excellent experiments. Good summary.

GRAVITY, WEIGHT AND WEIGHTLESSNESS. Film Assoc 11 min col/bw
Explores the relationship between gravity and weight. Free-fall explained. Use of research planes to creat weightlessness in order to study its effects upon man. Orbital velocity explained. Newton's classic experiment is demonstrated.

BEFORE SATURN. NASA 15 min col
Excellent history of rocketry from the days of early Greeks to the modern space program.

FREEDOM 7. NASA 28½ min col
Shepherd's suborbital launch. Includes part of the training he received for this launch; takes him through the last few days before the launch and shows his recovery and his reception aboard the carrier, Lake Champlain.

SPACEMOBILE. NASA 45 min col
Lecturer Herman Oberle discusses the history of rocketry. NASA projects are covered through demonstration and experimentation.

35mm Filmstrips

EARTH SATELLITE--A MAN MADE MOON. McGraw-Hill 36 fr col
Rocketry and forces concerned with launch with clearly illustrated launch concepts. A good section on satellite instrumentation.

EXPLORING THE SPACE AROUND THE EARTH. McGraw-Hill 59 fr col
Illustrates problems of space exploration. Includes principles of flight, Newton's Laws of Motion, escape and orbital velocity.

LEAVING THE WORLD. SVE 41 fr col
Generally related to rocketry with special emphasis on Kepler's Laws, apogee and perigee, and orbital speeds.

ROCKET POWER FOR SPACE TRAVEL. Jam Handy 35 fr col
Multistaging, rocket motors, Newton's Third Law of Motion and space stations.

2" x 2" Slides and Flat Pictures

DRAMATIC BLAST-OFF OF THE ATLAS. NatlAviationCounc
Force of rocket blast-off dramatically pictures in vivid color by General Electric.

Seventeen 8" x 10" glossy prints of Rockets-Vertols and rocket aircraft. Available from NASA.

10" x 10" Transparencies

Rocketry and Space Vehicles - Four transparencies, UNC, BAVE col

ST-3. Rocket engine.

ST-4. Jet Motor.

ST-5. A rocket will remain in orbit if the curve of its path is equal to or less than the curvature of the earth. The orbit in A is not circular because either the launching angle was too high or the speed of the rocket was too great.

ST-6. The thrust of a rocket is produced by expansion of gases in the combustion of the rocket engine.

Charts, Graphs, Demonstration Devices, and Field Trips

Demonstration Devices

Model Rocketry (Estes Industries, Box 227, Penrose, Colorado)

Model rockets are no more expensive than most other models. Some kits are $ .70 to $2.00 with engines (chemical solid fuels) being from $ .21 to $ .50 (in quantity).

Model Rocket News, a publication of Estes Industries, contains valuable information for the model rocketeer.

Model rocketry is a wholesome activity for earth and space science students.

Model Rocketry as a Student Activity: Excellent to extend the classroom into hobbies. Students must be safety conscious. Model rockets are safe if instructions are followed. Students do not make fuels to be used. Models are not to contain metal parts.

A variety of companies manufacture kits for construction or sell the parts to be used in self-designed models.

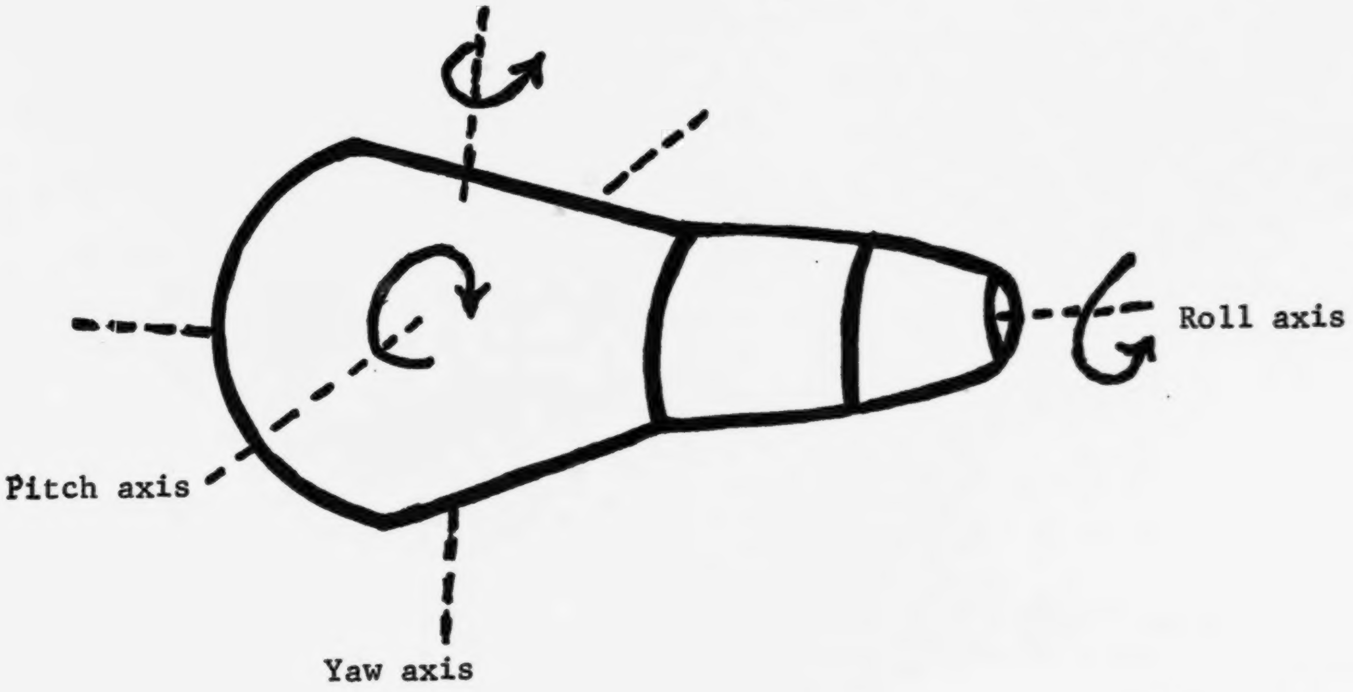
All firing is to be done under safe conditions:

1. Electrical circuit devices using nichrome wire.
2. In large fields with radius at least as wide as the rocket is to be fired in height.
3. No building or aircraft should be in the immediate area.
4. Some means of recovery--parachute, tumble, or glide must be used.
5. No wind--rockets are lost very easily in wind.

Energetic students can continue this hobby into related study areas which may become quite technical such as:

1. Rocket recovery principles
2. Multiple-staging
3. Stability factors
4. Altitude determination

DEMONSTRATION DEVICE FOR CAPSULE ATTITUDE CONTROL. Estes



A balsa wood model of a capsule or one formed from plastic may be found on toy counters. An empty plastic bottle of any general sort may be used to illustrate the principle of attitude control.

In wood drill three holes such that all are perpendicular--one hole running longitudinally, one laterally, and one on the vertical plane. Size of hole should be about the gauge of a large soda straw which will be used to illustrate the axis. In plastic the drill may be used or a hot nail for making the hole.

All axes are demonstrated separately, not together. A gimbaled model as a more advanced example of attitude control can be made.

Recordings--Magnetic Tape

THE SPACE STORY--NASA (4'30" 7.5 ips)
Live recording of rocket launchings at Cape Kennedy, including communications between ground control and astronauts in flight, etc.

FIELD TRIP TO ROSMAN NASA FACILITY.

NASA's Data Acquisition Facility at Rosman, North Carolina, was visited by a student group of nine and three adults. This facility is strategically located at the intersection of a chain of tracking stations running north and south with a similar chain of east and west stations. It is on Federally owned property in the Pisgah national Forest.

The 85-foot dish antenna was viewed from the control console, as it turned on its X-Y axis. The station's own power station was visited. The facility does not depend upon outside companies for its electrical power. A test tracking was conducted of TIROS VII while the group was present. Recording devices were shown to the students with a play-back of information from an interplanetary satellite.

SPACE EXPLORATION

C. MAN'S SATELLITES

Objective: To provide some understanding of the behavior and purpose of artificial earth satellites.

16mm Films

MAGNETOSPHERE. NASA 45 min col

Van Allen Belts in relation to space radiation. Could also be used when discussing psychological and physiological problems of space travel.

TELSTAR. AmTel&Tel 25 min col

Shows cooperation between agencies to prepare and launch this communication satellite. Tracking and use of transoceanic communications.

TIROS II--EXPERIMENTAL WEATHER SATELLITE. NASA 6 min col

Film shows launch of Tiros II. Satellite produces weather pictures of earth's cloud cover. Includes three months activities of Tiros I by television cameras.

A VOICE FOR MERCURY. NASA 12½ min col

Describes construction of NASA's vast tracking network of Mercury capsule around the world. Shows control work and elementary signals.

WHY COMMUNICATION SATELLITES. Film Assoc 12½ min col/bw

Shows the value of communication by satellites. Types: Echo, Telstar and Syncom. Discusses reflection of radio waves and the passage of television waves by the ionosphere. Good animation--good summary.

THE HARD ONES. NASA - 1965 15 min col

An overview of some of the kinds of engineering difficulties encountered in conceiving, designing, building, testing and launching of NASA's unmanned scientific and applications satellites. Centered around the solution of problems in the Orbiting Geophysical Observatory (OGO), the film shows development of Vanguard, Echo, Ranger, Syncom, Relay, Telstar, OAO and Nimbus.

LUNAR BRIDGEHEAD. NASA - 1964 29 min bw

The film presents on the spot coverage of the events surrounding the launch and successful flight of the Ranger VII spacecraft. Ranger VII transmitted, to earth, over 4000 high-resolution photographs as it approached the lunar surface, some of the pictures are included in the film.

16mm Film Clips

GLENN IN SPACECRAFT DURING FLIGHT. NASA (2'42") sil bw Clip No. A-11
Shots of Glenn in capsule, scenes showing view from his periscope and some of those taken by his on-board camera are shown.

ORBITING SOLAR OBSERVATORY (OSO). NASA (2'35") sil bw Clip No. G-1
Scenes of OSO's solar paddles spinning, engineers checking out and positioning mirror to reflect sun, OSO's solar paddles homing in on reflection of sun and Thor Delta launching OSO into orbit.

2" x 2" Slides and Flat Pictures

COMMUNICATIONS SATELLITE. NASA 36, 2" x 2" slides
NASA Slide show
A graphic illustration of the peaceful uses of communication satellites for global television and a world-wide communication network.

NASA PRODUCTION AIDS FOR TV, Part 2--Still Photographs. NASA
Provides background information as to behavior and purpose of artifical satellites.

Twenty-four 8" x 10" glossy prints of man's satellites for peaceful exploration of space. MOL (Manned Orbiting Laboratory), TELSTAR, RELAY, SYNCOM, ECHO II, TIROS, SMS (Synchronous Meteorological Satellite), NIMBUS, TRANSIT, EXPLORER, GEODETIC SATELLITE, BIOSATELLITE, MDS (Meteoroid Detection Satellite), IMP (Interplanetary Monitoring Platform), OSO (Orbiting Solar Observatory), AOSO (Advanced Orbiting Solar Observatory), OGO (Orbiting Geophysical Observatory), OAO (Orbiting Astronomical Observatory), RANDER, SURVEYOR, LUNAR ORBITER, MARINER, PIONEER.

RANGER VII MOON SHOTS--FLAT PICTURES AND FILM. NASA
Flat pictures taken from the Ranger VII television cameras can be used as a bulletin board in conjunction with the large Lunar Reference Mosiac Map. The craters Arzachel, Alphonsus, Guericke and Ptolemaeus can be located on the Lunar Reference Map and the flat pictures (arranged in sequential order) carefully observed as Ranger VII zeros in

on its target. Follow-up with narrated film RANGER VII MOON SHOTS makes excellent study of moon topography.

10" x 10" Transparencies

Man's Satellites - Five transparencies, UNC, BAVE

ST-7. Artificial earth satellites are useful in many ways.

ST-8. Telstar and Relay.

ST-9. Syncom.

ST-10. Nimbus meteorological satellite.

ST-11. Nimbus and graphic illustration of air mass.

Charts, Graphs, Demonstration Devices, and Field Trips

A NEW ERA IN COMMUNICATIONS (Communication Satellite Paper show). NASA
Approximately 48" x 36" chart series on types and progress of communication satellites. Colorful and useful for bulletin board displays.

NASA FACTS: An Educational Publication of the National Aeronautics and Space Administration.
NASA FACTS includes data, definitions, pictures, conceptual drawings, description of spacecraft experiments. Alouette--Canada's first satellite, Ariel--first international satellite, Explorer satellites, Explorer XVI,the Micrometeoroid Satellite, Mariner II reports, Orbiting Geophysical Observatory, Project Syncom, and Tiros publications are kept up to date.

PROJECT MERCURY. NASA
Approximately 48" x 36" chart series on Project Mercury. Colorful and useful for bulletin board displays.

TERRESTRIAL ATMOSPHERE AND SPACE. (chart) Denoyer
Exosphere, ionosphere, stratosphere and troposphere. Electro-magnetic waves and radiation from space.

HOLMES SATELLITE TRACKER: A Complete Home Tracking Station. Research Pub col
The tracker is a chart in full color designed as an aid for tracking artificial satellites from any location. Full directions for use are given.

SPACE EXPLORATION

D. MOON FLIGHT

Objective: To outline the procedures involved in traveling to the moon and to other members of the solar system.

16mm Films

CELESTIAL MECHANICS AND THE LUNAR PROBE. NASA 12 min col
Describes the mechanics of guiding lunar probes. Excellent animation of the moon's precession. Also good animation of the rotation of the earth and the moon.

MARTIAN EXPLORER. Boeing 12½ min col
Specialized plans for unmanned and manned space flights to Mars. Explains purpose of Mars exploration, Cesium Ion propulsion, and stabilization in space.

PROJECT APOLLO--MANNED FLIGHT TO THE MOON. NASA 13 min col
Steps to be taken by NASA to place men on the man and return safely. Principal feature of Gemini program, rendezvous and docking. Apollo spacecraft with Saturn I, IB, and 5 boosters. Sequence of events for lunar mission.

VOYAGE TO THE MOON. NASA 27 min bw
Preflight training of astronauts which includes docking simulator, moon gravity simulator, and animation of moon flight. Establishing lunar orbit, descent to moon's surface in LEM (Lunar Excursion Module). Moon exploration, blast-off from moon, rendezvous with command and service module, return to earth and re-entry in command module.

16mm Film Clips

C-3 APOLLO BOILER PLATE TESTING (COMMAND MODULE). NASA (3'30") sil bw
The Apollo Boiler Plate water drop test, import test, land drop test, and parachute drop test (dated).

C-2 APOLLO COMMAND MODULE CONSTRUCTION, TESTING. NASA (1'20") sil bw
Several Apollo Command Module mock-ups under construction, systems checkout, and windtunnel tests are shown.

C-6 APOLLO MISSION CONCEPT (animation). NASA (4'37") sil bw
Explains by use of animation. NASA's lunar landing program: Saturn I, IB, V booster, the Apollo spacecraft 3 sections, or modules.

B-4 GEMINI SIMULATION, TRAINING DEVICES. NASA (4'37") sil bw
A few of the many trainer simulation of flights used to familiarize the astronauts with conditions encountered and train them to react smoothly and quickly to any situation.

H-1 MARINER II. NASA (2'48") sil bw
Various scenes showing Mariner's solar panels, booster, ignition, launch, and tracking activities.

35mm Filmstrips

PROJECT APOLLO--MANNED FLIGHT TO THE MOON, Series I. NASA 25 fr col
Sequented projects--Man's first steps to explore the solar system; Project Mercury; Project Gemini; Project Apollo. Phases of program clearly explained--earth orbiting, docking, orbiting moon, LEM landing, lunar orbit, rendezvous and return to earth.

ROCKET TO THE MOON. McGraw-Hill 39 fr col
Explains rocketry problems as related to lunar explorations.

2" x 2" Slides and Flat Pictures

NASA PRODUCTION AIDS FOR TV, Part 2-- Still Photographs. NASA
Photographs and conceptual drawings to further an understanding of traveling to the moon. Nos. 11, 12, 13, 16, 20, 21, 22, 23, 24, 25, 35 through 50, 72, 73, 84, 86.

PROJECT GEMINI. NASA
Eleven 8" x 10" prints of Project Gemini.

PROJECT APOLLO. NASA
Eighteen 8" x 10" prints of Project Apollo.

PROJECT APOLLO. NASA 2" x 2" slides
NASA Slide Show
Graphic illustrations of the Gemini project and preparations from manned flights to the moon and return to earth.

10" x 10" Transparencies

Moon Flight - Five transparencies, UNC, BAVE col

ST-12. Project Apollo.

ST-13. Gemini Capsule.

ST-14. Tools of the Trade.

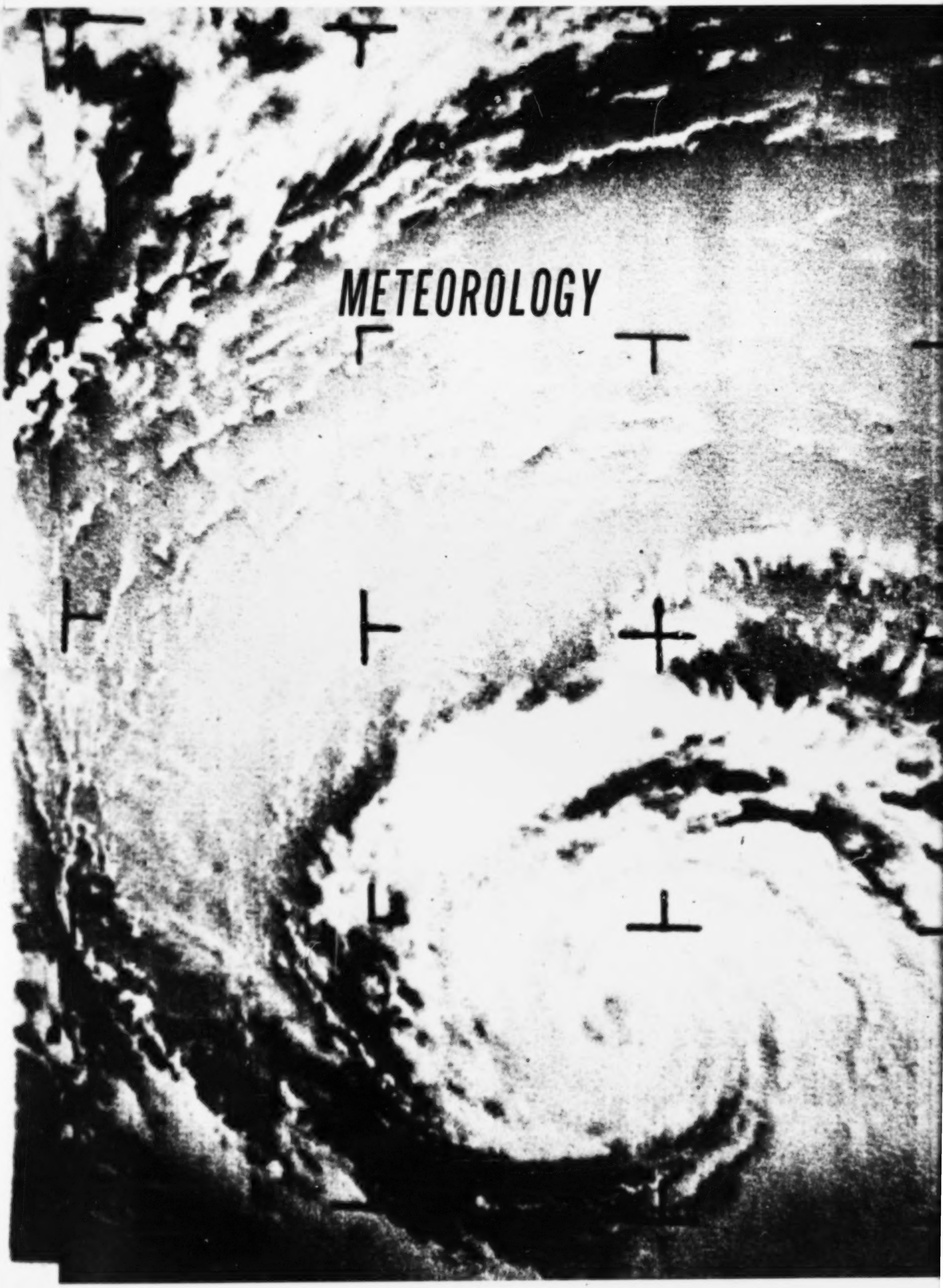
ST-15. U. S. Plan to land a man on moon and cost of space program.

ST-16. Telescope (2b)

Charts, Graphs, Demonstration Devices, and Field Trips

MAPS OF MOON--USAF Lunar Reference Mosaic. Supt of Documents, GPO
Excellent composite photograph of the surface of the moon. Size approximately 36" square.

KEY MAP OF MOON FLIGHTS. Nat'l Aviation Educational Council
This map prepared by Rocketdyne Division of North American Aviation illustrates that the time of flight of a ballistic missile fired at the moon is extremely sensitive to the initial velocity of the final stage.



METEOROLOGY

AUTOMATIC PICTURE TRANSMISSION (APT) PHOTOGRAPH

The Camera in the Nimbus-I weather satellite photographed Hurricane Ethel (top right corner) at 11:56 a.m. EDT today (Sept. 11, 1964), while the storm-hunting satellite was streaking north at an altitude of 490 miles, on its 210th orbit. Ethel at 6 a.m. was approximately 850 miles east of Florida and 350 miles south, heading in the approximate path of Hurricane Dora, traveling about five M.P.H.

North Carolina State Department of Public Instruction Curriculum Bulletin

Suggested Principles and Activities for Eighth Grade Space Science

METEOROLOGY

(Paragraphs 8-100 through 8-124)

North Carolina Department of Conservation and Development, Division of Mineral Resources. *Free*)

Discuss the topographic divisions of North Carolina. Assign reports to individual students on North Carolina topography, soils, specific minerals and common rocks found in North Carolina.

VII. METEOROLOGY

A. Nature of the Atmosphere

8-100. ***The atmosphere consists of a mixture of gaseous components.***

ACTIVITY:

Have the students make a circle graph showing the percent by volume of the gases that make up the atmosphere.

Fixed components of dry air	Percent
Nitrogen	78
Oxygen	21
Argon and other rare gases	1

Note that the water vapor in the air is the most variable part of the air and is therefore not included in the so-called "fixed components" of the atmosphere; it varies from a fraction of 1% to 4% for moist air.

8-101. ***The atmosphere has several distinct layers.***

ACTIVITY:

Have students read about the layers of air in a number of supplementary texts. Have several students make charts of the layers from the information gathered. This might be accompanied by reports of ascents into the stratosphere or beyond, by balloon, plane or rocket.

8-102. ***Each layer of the atmosphere has different characteristics.***

ACTIVITY:

Assign small groups of students the following questions for problem solving:

(1) Why does the jet stream blow?
(2) What causes the northern lights?
(3) What keeps radio waves from going into outer space?

B. Heating and Cooling of the Atmosphere

8-103. ***Temperature measurements are based on the fact that most substances expand when the temperature rises.***

ACTIVITY:

Materials: flask
one-hole stopper

glass tube
tape
white card
Bunsen burner

Fill the flask with colored water. Put the one-hole stopper with the glass tube into the flask. Tape the outer end of the glass tube to a white card. Heat the flask briefly over a Bunsen burner or set it in the sunlight. Notice the rise in the height of the water column in the tube. Cool the flask by placing it in cold water. On the following day, when the water in the flask is at the same temperature as the air of the room, make a mark on the white card taped to the tube at the water level in the tube. Opposite this mark indicate the room temperature as indicated by the classroom thermometer. Invite suggestions as to how further calibration might be done.

8-104. ***The amount of the sun's energy absorbed depends upon the characteristics of the surface upon which it falls.***

ACTIVITY A:

Materials: dry sand
dirt
water
containers
thermometers

Place equal amounts of dry sand, dirt, and water in three separate containers. Insert a thermometer into each container and place in the sunshine near each other. Record the temperatures every ten minutes for half an hour. Remove the containers from the sunshine and continue to record temperatures every ten minutes for another half hour. Record your observations.

ACTIVITY B:

Materials: 2 test tubes
soot from a candle
2 thermometers
water
a large beaker

Pour equal amounts of water into two test tubes, one of which is covered with soot. Insert thermometers into each and set the two tubes side by side in a beaker in direct sunlight. Compare the temperatures after a period of about 20 minutes. Relate the results to the causes of local winds.

8-105. ***Land absorbs radiant energy more rapidly than water.***

ACTIVITY:

Materials: soil
water
thermometers
2 dishes or beakers

Place some soil in one beaker and fill the other to the same level with water. Allow the containers to remain in a shaded place until their temperatures are the same. Then set the beakers in direct sunlight. Support a thermometer in each beaker with the bulb just covered. Read the thermometers every 10 minutes during a class period and determine which gains heat faster. Relate the results to the development of land and sea breeezs.

8-106. ***The surface of the earth is unequally heated by solar radiation.***

ACTIVITY:

Materials: screen wire
slide projector
large globe (12-16 inches diameter)

Illuminate the globe by the light of the projector. Place the screen wire in the projector as if it were a slide. Adjust the focus so that the screen mesh may be clearly seen on the globe. Point out that the amount of light and heat passing through each square of the screen is the same. Note that where the light strikes the globe most directly, the squares are smallest and indicate the greatest concentration of heat and light. The larger squares at the two polar regions represent a low concentration of heat and light. Note that the same situation exists at sunrise and sunset on the globe.

8-107. ***Heat may be transmitted from place to place by the process of radiation, conduction and convection.***

ACTIVITY A (Radiation):

Materials: electric iron

Heat an electric iron, hold it about 12 inches above the hand. The side near the iron should feel warm and the other side will remain cool.

ACTIVITY B (Conduction):

Materials: nail

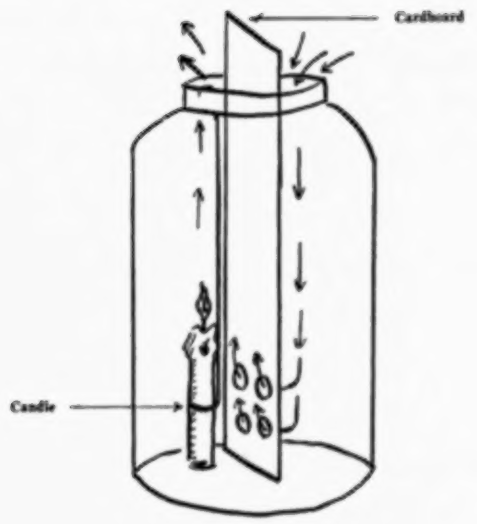
Heat one end of a large nail. Have a few drops of candle wax which has hardened on the other end. As the heat is conducted through the nail, notice the wax soften and fall.

ACTIVITY C (Convection):

Materials: candle
wire
tall glass jar
cardboard

Lower a lighted candle attached to a wire into a tall glass jar. The flame will die when the oxygen inside the jar is used up. Now insert a piece of cardboard into the jar to divide the space inside the jar. (Several holes should be cut in the cardboard below the height of the flame.)

Re-light the candle and lower it into the jar. It will burn readily now as a current of cool air enters the jar on one side of the divider while the heated air expands and rises out on the other side.



8-107 C

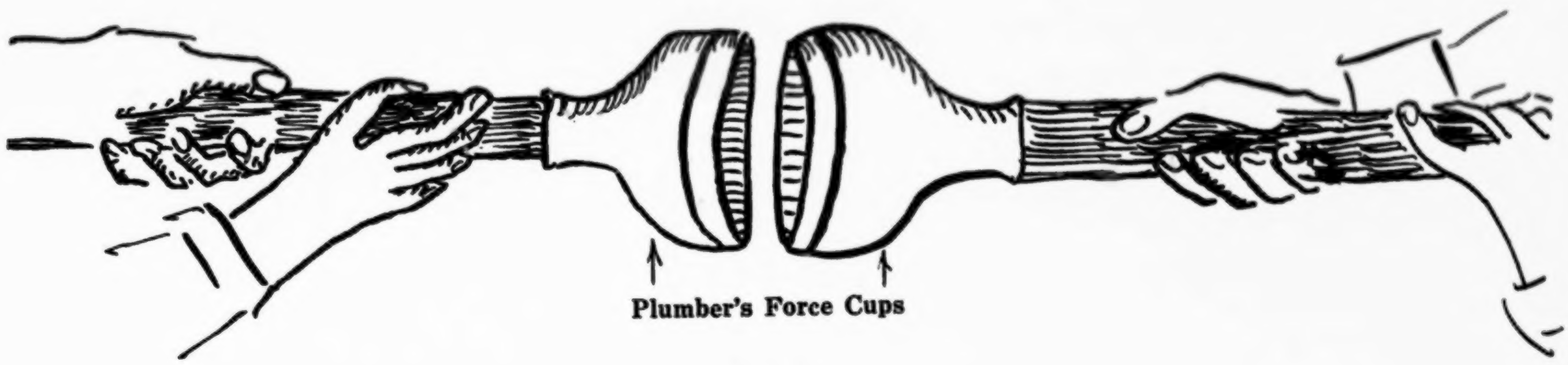
C. The Atmosphere's Changing Pressure

8-108. ***The pressure of air is caused by its weight.***

ACTIVITY A:

Materials: 2 plumber's force cups (rubber plungers)
2 strong boys

Wet the bottoms of two plumber's force cups (rubber plungers). Press them together to force out the air between them. Then have two boys pull them apart. Notice how much force is necessary for this feat.



8-108 A

ACTIVITY B:

Materials: glass tube
rubber band
two-hole stopper
bent tube
gallon bottle

Fasten a balloon to one end of a glass tube with a rubber band and insert the free end of the tube into one of the holes in the small end of a two-hole stopper. Place a bent tube in the other hole. Push the balloon and stopper into a gallon bottle and suck on the bent tube to reduce the atmospheric pressure in the bottle. Air will flow through the tube and inflate the balloon to the point at which the pressures are balanced again.

ACTIVITY C:

Materials: beaker
water
small piece of cardboard

Fill a water glass to the brim with water and place a small piece of cardboard over it. Holding the cardboard in position with the palm of the hand, invert the glass, then take away the hand. Set the inverted glass of water on a smooth table top and slide it off the card onto the surface. Move it across the table without lifting it. Hold a vessel under the edge of the table and let the water run out.

ACTIVITY D:

Materials: cork
bottle
vacuum pump
bell jar

Place a corked bottle beneath a bell jar and exhaust the air from the jar. (Use the vacuum pump.) The cork should pop from the bottle. Some experimentation may be necessary to find the right type of bottle and to determine the force with which to cork it.

D. Water Vapor Enters and Leaves the Atmosphere

8-109. ***Water vapor enters the air from wet surfaces.***

ACTIVITY:

Materials: a cloth
water
clothes hanger
yard stick
weight

Dip a cloth in water, wring it out and hang it over a clothes hanger. Hook the clothes hanger on one end of a long stick and balance the other end with a weight. As water evaporates, the balance is quickly upset. Cite other examples of water entering the air by evaporation from wet surfaces.

8-110. ***Humidity measurements are based on the principles that some things expand when the water vapor in the air increases and that evaporation causes cooling.***

ACTIVITY:

Materials: 2 fahrenheit thermometers (each mounted on a scale)
scissors
cotton
water
a fan of some type

Remove one of the thermometers from its scale and cut the scale off at the 20° mark. This permits the bulb to extend beyond the scale. Remount the thermometer. Wrap some absorbent cotton around this bulb and moisten the cotton with water. Fan both thermometers and compare the readings. Use the table in the appendix to convert the difference in temperature readings into relative humidity.

8-111. ***Humidity refers to the presence of water vapor in the air and may be determined by the use of a hygrometer or psychrometer.***

ACTIVITY:

Materials: spring scale
ringstand
sponge
water

Demonstrate the meaning of relative humidity by comparing the air to a sponge. Weigh a dry sponge on a spring scale suspended from a ringstand. Remove the sponge and add water until the sponge is soaked but not dripping. Weigh the sponge again and compute the weight of water. The sponge is saturated if it contains 100% of the moisture it is capable of holding.

Thoroughly dry the sponge in the above activity. This time add one-half or one-fourth of the known amount of water the sponge will hold. It can now be said that the sponge (which represents the air) is 50% or 25% saturated.

Add more than the known amount of water the sponge will hold. The excess water will drop out of the sponge. This is comparable to supersaturation in the atmosphere. Relate to activity 8-110 and the use of the psychrometer.

8-112. ***The dew point varies with humidity and temperature.***

ACTIVITY:

Materials: ice cubes
polished metal can
thermometer

Add the ice cubes to the polished metal can containing a thermometer. Stir the mixture ot ice and water and at the instant a fog forms on the outside of the metal can, due to the condensation of the moisture in the air, record the temperature. This temperature is the dew point.

8-113. ***Clouds or fog occur when moist air is cooled sufficiently.***

ACTIVITY:

Materials: milk bottle
cold water
hot water
ice cubes

Fill a milk bottle with hot water, then pour out most of the water, leaving about an inch in the bottom. Place an ice cube on the mouth of the bottle. Set up a control, using cold water instead of hot. Ask pupils to explain why the fog forms in one bottle and not in the other.

8-114. ***Clouds may form when moist air is cooled by expansion.***

ACTIVITY:

Materials: bicycle pump
milk bottle
cork

Drill the cork so that the tube from the pump will fit tightly through it. Wash out the inside of the bottle to moisten it. Hold the cork in place in the mouth of the milk bottle. When the air in the bottle is compressed, remove the cork suddenly or let it blow out because of the pressure. As the air in the bottle decompresses, condensation will take place and a "cloud" or fog will fill the bottle.

8-115. ***Water is continually being evaporated and/or condensed in the rain cycle, causing a constant exchange of water from place to place.***

ACTIVITY:

Materials: water
Bunsen burner or heat source
beaker
flask (florence)

Heat some water until it is near the boiling point. Pour the hot water into a beaker until it is about two-thirds full and rotate the glass so as to wet the sides all the way to the top. Put some cold water into a florence flask and set the flask at an angle on the beaker.

Water will evaporate from the surface in the beaker and condense on the cold flask. Observe that drops of the condensed water will continue to fall back into the beaker for many minutes. Point out that evaporation, condensation and precipitation proceed inside the beaker just as they do on the outside.

E. Air Masses and Their Weather

8-116. ***Air masses and associated fronts generally move from west to east.***

ACTIVITY:

Materials: newspaper weather maps (ten or more in a series)
filing cards
paste

Encourage pupils to save newspaper weather maps until they have a series of ten or more. Cut out the maps carefully and paste them on filing cards. Make sure that all maps are pasted in the same position; then staple one end of the pack of cards. Draw the other end of the pack over the thumb in such a way that the cards are viewed in rapid succession. Note the west to east movement of the weather fronts.

8-117. ***The cold air from the polar high pressure area spreads southward in all directions.***

ACTIVITY:

Materials: dry ice
globe
forceps

With the forceps pick up a small piece of dry ice and set it over the North Pole of the globe. *Caution:* Do not touch the dry ice with your hands. Notice how the vapor moves southward over the globe in all directions.

8-118. ***The rotation of the earth causes a deflection of the general air movements in the planetary wind belts over the earth (coriolis deflection).***

ACTIVITY:

Materials: slate globe
test tube
water

Have a student spin the globe rapidly in a counterclockwise direction while another student pours half a test tube of water on the globe at the North Pole. Let the globe stop spinning and examine the path of water as it ran down over the globe.

8-119. ***Some storms are especially energetic and destructive; and are identified by special names.***

ACTIVITY:

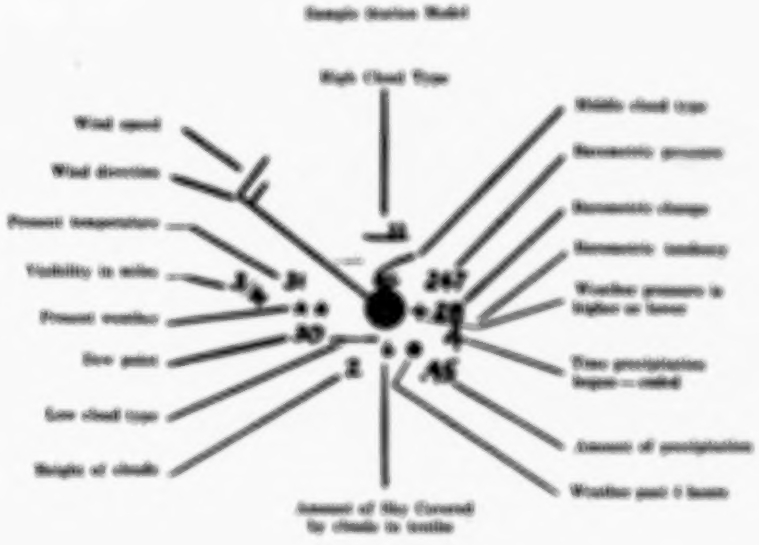
Assign interested individuals and small groups to study the subjects of tornadoes, hurricanes, thunderstorms and blizzards.

8-120. ***Weather conditions at specific stations are indicated by information plotted in position around the station on weather maps.***

ACTIVITY:

Materials: flannel board
flannel cloth

Lay out a weather map station model on a flannel board. Make weather symbols and numerals from small pieces of flannel and attach them in the proper position. Change the symbols and other information in this weather station model in accordance with data taken from the weather map in the morning newspaper or from the daily map from the U. S. Weather Bureau.


Sample Station Model
High Cloud Type
Wind speed
Wind direction
Present temperature
Visibility in miles
Present weather
Dew point
Low cloud type
Height of clouds
Middle cloud type
Barometric pressure
Barometric change
Barometric tendency
Whether pressure is higher or lower
Time precipitation began — ended
Amount of precipitation
Weather past 6 hours
Amount of Sky Covered by clouds in tenths
31
3/4
30
247
+28
2
.45

8-120

S-121. ***Results of many simultaneous observations are plotted on maps to portray weather patterns over a large area.***

ACTIVITY:

Materials: daily weather map from U.S. Weather bureau

Acquaint the students with the symbols used on weather maps: isobars, isotherms, fronts and air masses. Point out the small scale maps bordering the main map. Have students determine the information presented on these maps.

F. The Weather Bureau and Its Work

S-122. ***The U. S. Weather Bureau is a national agency which makes weather information available to the public.***

ACTIVITY:

(a) Visit a nearby weather station.
(b) Invite a professional meteorologist to talk to the class.
(c) Have some students report to the class on the U. S. Weather Bureau and the services it renders to our nation.
(d) Have students report on careers available in meteorology.

S-123. ***Modern meteorology makes use of accurate recording instruments which enable the meteorologist to forecast the weather.***

ACTIVITY:

Materials: selected pictures
bulletin board

Make a bulletin board display of pictures of the following instruments and point out their uses:

Barometer—air pressure
Thermometer—temperature
Hygrometer—moisture
Anemometer—wind speed
Wind vane—wind direction
Rain gauge—precipitation

Sunshine duration transmitter—solar radiation
Radiosonde—records weather factors at upper levels
Alidade—height of clouds
Theodolite—wind currents
Nephoscope—cloud drift

G. Factors that Control Climate

S-124. ***Climate is influenced by the geography of the area.***

ACTIVITY:

Materials: bulletin board
selected pictures
world map

Select and arrange on the bulletin board, a series of photographs or pictures depicting scenes from outstanding regions of the world. Examples: Congo region, Sahara Desert, Holland, Norway, China, Egypt, Switzerland, Amazon Region, Grasslands of Africa, Mediterranean land, The Far North, and The Far South.

Have students find the following information about the selected places: Altitude, latitude, nearness to sea, mountain ranges, ocean currents, prevailing winds and other factors.

8-125. ***Many different parts of the world have similar climates.***

ACTIVITY A:

Materials: chart paper
poster materials

Make a colored map of the principal world climates: Tropical, middle-latitude, and polar.

ACTIVITY B:

Discuss the climate of North Carolina.

VIII. OCEANOGRAPHY

A. The Ocean Floor

8-126. ***The oceans cover about three-fourths of the earth's surface.***

ACTIVITY:

Materials: globe

Point out the true land-sea ratio on the earth. Call attention to the fact that the continents divide a continuous sea. Review the names of the five major oceans; Atlantic, Pacific, Indian, Arctic and Antarctic.

8-127. ***The ocean floor topography includes slopes, canyons, ridges, mountain ranges, deep trenches and broad plains.***

ACTIVITY:

Materials: a physiographic diagram of the Atlantic Ocean (See Heezen, Bruce C. and others, *The Floors of The Oceans.*)

Display the diagram on the bulletin board and have students observe the topographic features of the Atlantic ocean floor. The old idea that the sea floor is flat should be corrected by pointing out that the topography of the sea floor is similar to that of the land. Point out mountain ranges (Mid-Atlantic Ridge of which the Azores are a part).

8-128. ***The sediments on the ocean floor come from eroded land and the sea life.***

ACTIVITY:

Discuss erosion, transportation and deposition of sediments. To show the great amount of sediment carried to the sea each year, give the data on the sediment load of the Mississippi which drains about two-thirds of the United States. Most sediment transported this way is deposited on the continental shelf.

METEOROLOGY

A. Nature of the Atmosphere.

B. Heating and Cooling of the Atmosphere.

C and D. The Atmosphere's Changing Pressure; Water Vapor Enters and Leaves the Atmosphere.

E. Air Masses and Their Weather.

F. The Weather Bureau and Its Work.

Educational Media Resources

16mm Films and Film Clips
35mm Filmstrips
2" x 2" Slides and Flat Pictures
10" x 10" Transparencies
Charts, Graphs, Demonstration Devices, and Field Trips
Self-Instructional Devices (8mm film loops - programed instruction)

METEOROLOGY

A. NATURE OF THE ATMOSPHERE

Objectives:

1. To become familiar with the normal composition of the atmosphere and the way in which it is naturally maintained.
2. To gain an understanding of the nature of the upper atmosphere.
3. To provide a basis for understanding the source of air pressure and the methods by which it is measured.
4. To develop an understanding of the cause for various phenomena produced by interaction between the sun's radiation and the atmosphere.

16mm Films

UNCHAINED GODDESS. BellTelCo 59 min col
What modern science has learned about winds, clouds, precipitation, and lightning and how they combine to cause weather.

INSIDE THE WEATHER. United World 13½ min col
Basic weather phenomena and local weather conditions are shown. Good animation and diagrams of the atmosphere and troposphere, air movements, moisture of atmosphere and temperature changes.

35mm Filmstrips

EARTH'S ATMOSPHERE. Jam Handy 37 fr col
Shows layers of the atmosphere. Especially good of the ionosphere and ozone layers. Shows the effect of the decreased pressure on man as he ascends into the atmosphere.

PHYSICAL PROPERTIES OF AIR. Jam Handy 40 fr col
Gaseous components of air. Properties of air.

AIR PRESSURE (Science Adventure Series, Weather No. 2). FilmstripHouse 36 fr col
Layers of the atmosphere. Shows how earth's gravity holds the atmosphere. High and low pressure systems. Simple activities for students.

WHAT IS AIR PRESSURE. Jam Handy 44 fr col
Describes air masses as related to air pressure.

4" x 5" Transparencies and Flat Pictures

FAITH 7 (pictures taken on board by Gordon Cooper). NASA col
Nos. 8, 10, 11, 12, 14, 15, 22, 27, 28. These shots show the earth's atmosphere, cloud covers and geographic features from space.

10" x 10" Transparencies

Nature of the Atmosphere - Two transparencies, UNC, BAVE col

MT-1. The principle of the Torricellian barometer.

MT-2. The layers of the atmosphere.

METEOROLOGY

B. HEATING AND COOLING OF THE ATMOSPHERE

Objectives:

1. To become acquainted with the driving forces of air movements in the atmosphere.
2. To become acquainted with the global wind pattern.
3. To develop an understanding of the role of local conditions in the production of winds.

16mm Films

FOG AND LOW CEILING CLOUDS (#FAN 101). Federal Av 23 min col free
Advection fog, ground fog, characteristic of and conditions conducive to fog, with an explanation of the theory of fog formation. (Slightly above level of average 8th grade.)

FOG AND LOW CEILING CLOUDS (#FAN 102). Federal Av 9 min col free
Upslope fog, frontal fog. Illustrates how upslope fog, frontal fog, and low stratus clouds are generated. Warm front fogs and cold front fogs are compared, their formation analyzed and their effect on flying discussed. (Slightly above average 8th grade level.)

GREAT WINDS, PART I: General Circulation. United World 11 min col/bw

General circulation of wind due to the rotation of the earth and the angle of the sun's rays strike the surface of the earth. Shows high and low pressures as related to air movements and storms.

GREAT WINDS, PART II: Distribution of Pressure and Winds. United World
11 min col/bw
Land and sea breezes illustrated. Movements of the air caused by the heating of the atmosphere by the sun.

WINDS GREAT AND SMALL. Cenco 12 min col/bw
Atmospheric circulation due to heating of the atmosphere by the sun and the earth's rotation. Land and sea breezes. Excellent vocabulary.

35mm Filmstrips

WHY DOES THE WIND BLOW?. SVE 33 fr col
Explains causes of local winds, jet stream, prevailing winds. Actual photos of a tornado, hurricane and blizzard.

10" x 10" Transparencies

Heating and Cooling of the Atmosphere - Four Transparencies, UNC, BAVE

MT-3. The wind belts of the earth.

MT-4. Jet streams, shown on a polar projection.

MT-5. Unequal heating of land and water results in land and sea breezes.

MT-6. Vertical view of air masses at cold and warm fronts.

C. and D. THE ATMOSPHERE'S CHANGING PRESSURE; WATER VAPOR ENTERS AND LEAVES THE ATMOSPHERE

Objectives:

1. To create an awareness of the presence and amount of moisture in the air.
2. To develop skill in interpretation of the methods for expressing the humidity of the atmosphere.
3. To gain an understanding of the way in which cloud water droplets are formed.
4. To become acquainted with basic cloud formations.
5. To study the conditions which cause precipitation of atmospheric moisture.

16mm Films

CLOUDS ABOVE. Bailey 9 min col
Shows types of clouds.

WATER IN THE AIR. Cenco 12 min col/bw
Showshow water in the atmosphere affects our weather. Explains the water cycles and types of precipitation.

WHAT MAKES WEATHER. Cenco 14 min col/bw
Evaporation and condensation. Movement of warm and cold air. Precipitation. Water cycle.

WHEN AIR MASSES MEET. Cenco 12 min col/bw
Atmospheric moisture condensation is related to air mass movements.

35mm Filmstrips

MOISTURE IN ATMOSPHERE (Science Adventure Series, No. 4). Filmstrip House 36 fr col $5
Cloud types shown. Simple activities for students illustrated.

WHY DOES IT RAIN, SNOW, HAIL AND SLEET?. SVE 39 fr col
Water content of the air. Types of precipitation. Weather prediction by Tiros satellite. Actual photos taken many miles above the earth.

2" x 2" Slides and Flat Pictures

CLOUDS AND WEATHER. Shuler 40 slides col
These slides could be used to show cloud types. Some excellent and unusual storm shots are included.

NASA Still Photographs.
Nos. 61, 65. These show Tiros satellite photos of cloud formations.

10" x 10" Transparencies

Atmosphere's Changing Pressure and Atmospheric Moisture - Three Transparencies, UNC, BAVE

MT-7. Air Movements.

MT-8. Hydrologic Cycle.

MT-9. Water Cycle.

METEOROLOGY, 202-3, CLOUD TYPES. Beseler
Static shows cloud types at different altitudes. Overlay adds in objects which resemble the basic cloud types.

E. AIR MASSES AND THEIR WEATHER

Objectives:

1. To become aware of the existence of air masses, their origins and their movements.
2. To gain an understanding of the role of air mass boundaries in the production of weather changes.
3. To develop some skill in the interpretation of weather changes in terms of frontal movements.
4. To become familiar with the various types of severe weather disturbances.

16mm Films

COLD FRONT. Federal Av 15 min col
Explains the formation, characteristics and dangers of a cold front. Demonstrates how to avoid hazards of the cold front either high or low front level. (Slightly above average 8th grade level).

WARM FRONT. Federal Av 18 min col
Explains the meeting boundaries of warm and cold air, dangerous stratified layers of clouds formed; how to plan a course around them; types of visibility; precipitation and ceiling condition, their location; cirrus, cirrus stratus and altostratus clouds.

WEATHER, WHY IT CHANGES. Coronet 11 min col/bw
Shows air masses; fronts--cold, warm, occluded and stationary; storms--cyclone, anticyclone, hurricane and tornado.

WHEN AIR MASSES MEET. Cenco 12 min col/bw
Explains air masses and weather fronts. Purpose given at the beginning and summary at the end. Very good.

35mm Filmstrips

HEAT AND THE ATMOSPHERE (Science Adventure Series, No. 1). Filmstrip House 38 fr col
Very clearly illustrated explanation of air masses and sun's heating of the earth's atmosphere. Simple activities for students.

WHY DOES THE WEATHER CHANGE?. SVE 39 fr col
Air masses. Explains warm, cold stationary and occluded fronts. General information. Good introductory filmstrip.

2" x 2" Slides and Flat Pictures

MA 4-12 HURRICANE DEBBIE. NASA col
Counterclockwise movement of a hurricane is shown through color photography.

NASA Still Photographs.
Weather Satellite shots show cloud formations and storms.

10" x 10" Transparencies

Air Masses and Their Weather - Three transparencies, UNC, BAVE

MT-10. Polar air mass is shown moving from Canada into the U. S. Lower left inset indicates uniform conditions that prevail within the air mass. (shown vertically)

MT-11. The types of air masses that influence weather in North America.

MT-12. View showing the vertical development of a cyclone or low, corresponding to Stage E.

F. THE WEATHER BUREAU AND ITS WORK

Objectives:

1. To develop familiarity with the methods used to observe atmospheric conditions.
2. To learn the means by which weather data is analyzed.
3. To gain skill in the interpretation of weather maps.
4. To become acquainted with the principles of weather forecasting.

16mm Films

BE YOUR OWN WEATHERMAN. Cenco 13 min col/bw
Shows how to predict the weather by measurement of temperature of the air, air pressure, humidity, wind direction and velocity, cloud formation, amount and kind of precipitation. Illustrates the making of simple measurement instruments which could be easily made by students.

HURRICANE HUNTERS. U. S. Navy 27 min bw
Shows the Navy's hurricane hunters. A flying laboratory to determine origin and location of hurricanes. Involves communication and warnings as the hurricanes are tracked. The Navy plane is shown as an actual flying laboratory.

35mm Filmstrips

WIND (Weather No. 3, Science Adventure Series). Filmstrip House 36 fr col

Demonstrates making of simple weather instruments and presents nice shots of storms and storm formations.

2" x 2" Slides and Flat Pictures

PROJECT GEMINI PHOTOGRAPHS. NASA

These are used to show how relief map analogies will be made. These photographs show some global weather patterns.

WEATHER SATELLITES. NASA

These slides will aid students in becoming familiar with the use of weather satellite reports as a method of observing atmospheric conditions.

STILL PHOTOGRAPHS. NASA

These photographs show satellites designed for meteorological observations and pictures taken of cloud formations and storms.

WEATHER SATELLITE SHOTS. NASA

Views of weather conditions as taken from weather satellites.

10" x 10" Transparencies

The Weather Bureau and Its Work - Two transparencies, UNC, BAVE

MT-13. Vortex centered near 57 N, 76 W with front east and south.

MT-14. Symbols used in the construction of station models.

WEATHER INSTRUMENTS (202-6, Meteorology). Beseler

Static transparency illustrating weather instruments: rain gauge, barometer, thermometer, radio balloon, wind anemometer.

Charts, Graphs, Demonstration Devices, and Field Trips

WEATHER SCIENCE STUDY KIT. Supt. of Documents, GPO

Produced by the U. S. Weather Bureau, this kit contains a variety of useful materials and resource bibliographies for both the student and the teacher.

CORONET LEARNING PROGRAMS: HOW WE FORECAST THE WEATHER.

Programed by Learning, Inc., for Coronet Instructional Films.

FIELD TRIP: VISIT TO A WEATHER STATION.

Purpose:

1. To see the preparations being made for a radiosonde launch.
2. To see the launching and tracking process of a radiosonde.
3. To hear and see the recording and interpretation of radiosonde data on humidity, temperature, and pressure.

Arrangements are made through the weather station officials with the purposes outlined above. The visit in this case was to the Greensboro, Winston-Salem, High Point Airport Weather Station. Two launchings are conducted daily 6:00 a.m. and 6:00 p.m. Arrival should be well before launch time in order to see the radiosonde devices calibrated. Students should see and feel the helium balloon being prepared. A tracking of the radiosonde at some stations (Greensboro is one of these) is done to measure winds aloft.

Data being received on a tape is observed and technicians interpreting this on adiabatic charts form a line profile upon which humidity, temperature and pressure are recorded.

While the technicians are continuing their work, earlier similar charts are pointed out to students. Radiosondes rise 18 to 20 miles which gives a profile of the troposphere, the tropopause, and parts of the stratosphere.

APPENDIX A

SOURCE LIST

Academy Films. Academy Films, 1145 North Las Palmas Ave., Hollywood 38, Calif.

American Tel & Tel. American Telephone & Telegraph, 195 Broadway, New York, N. Y.

Association. Association Films, Inc., Broad at Elm, Ridgefield, N. J.

Atlantis. Atlantis Productions, Inc., 7967 Sunset Blvd., Hollywood 46, Calif.

Bailey. Bailey Films, 6509 DeLongpre Ave., Hollywood 28, Calif.

Bell Tel. *Bell System Telephone, (Free films distributed in North Carolina through Modern Talking Pictures, 501 N. College St., Charlotte, N. C. 28206.)
*Nearest Bell System office.

Beseler. Charles Beseler, Co., 219 South 18th St., East Orange, N. J.

Boeing. Boeing Company, News Bureau, P. O. Box 3707, Seattle 24, Wash.

Cenco. Cenco Educational Films, 1700 Irving Park Rd., Chicago, Ill. 60613.
Coronet. Coronet Instructional Films, Coronet Building, Chicago, Ill. 60601.
Denoyer. Denoyer-Geppert Co., 5235 Ravenswood Ave., Chicago, Ill. 60640.

Dimension. Dimension-Churchill Films, 6671 Sunset Blvd., Los Angeles 38, Calif.

Disney. Walt Disney Productions, 237 N. Northwest Highway, Park Ridge, Ill.

Douglas Aircraft. Douglas Aircraft Corporate Offices, Attn: George Sperry, Advertising Dept., Film Service, 3000 Ocean Blvd., Santa Monica, Calif.

EBF. Encyclopaedia Britannica Films, Inc., 1150 Wilmette Ave., Wilmette, Ill. 60091.

Federal Av. Federal Aviation Agency, Film Library, AC-142.1 Aeronautical Center, P. O. Box 1082, Oklahoma City, Okla.

Film Assoc. Film Associates of Calif., 11014 Santa Monica Blvd., Los Angeles 25, Calif.

Filmstrip House. Filmstrip House, 434 Park Ave., New York, N. Y. 10016.

C. S. Hammond. C. S. Hammond Co., 515 Valley St., Maplewood, N. J.

Hubbard. T. N. Hubbard Scientific Company, Box 105, Northbrook, Ill.

Instructo Products. Instructo Products Company, Division of Jacronda Mfg. Co., 1635 North 55th St., Philadelphia, Penna.

Int Flm Bur. International Film Bureau, 332 South Michigan Ave., Chicago, Ill., 60604.

Jacronda. See Instructo.

Jam Handy. Jam Handy Organization, 2821 East Grand Blvd., Detroit 11, Mich.

Life Filmstrips. Time & Life Building, Rockefeller Center, New York, N. Y. 10020

McGraw-Hill. McGraw-Hill Book, Co., Text-Film Div., 330 West 42nd St., New York, N. Y. 10036.

Moody. Moody Institute of Science, Educational Film Division, 11428 Santa Monica Blvd., Los Angeles, Calif. 90025.

NASA. For a complete list of NASA publications write for:
NASA Educational Publications, Educational Publications, AFAD-1, National Aeronautics and Space Administration, Washington, D. C. 20546.

NASA Film Service. A list of the addresses of the NASA film libraries is given with a map showing distribution centers for NASA films. Distribution Branch, AFAD-2, Washington, D.C. 20546.

National Aviation Educ. National Aerospace Education Council, Materials of Instruction, Room # 616 Shoreham Bldg., 806 15th St., N.W. Washington, D. C. 20005

Northrop. Northrop Space Laboratories, 9744 Wilshire Blvd., Beverly Hills, Calif.

Redstone. Redstone Arsenal Research Division, Rohm & Haas Co., Attn. Librarian, Huntsville, Ala.

Research Pub. Research Publications, Inc., 1687 Laurel St., San Carlos, Calif.

Shuler. Dr. Jay Shuler, 43 Kirkwood Lane, Greenville, South Carolina.

SVE. Society for Visual Education, Inc., 1345 Diversey Parkway, Chicago, Ill. 60614.

Supt. of Documents, GPO. Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

United World. United World Films, 1445 Park Ave., New York, N. Y. 10029.

U. S. Navy. U. S. Navy, Bureau of Naval Weapons, Commandant, Sixth Naval District, U. S. Naval Base, Charleston, S. C.

UNC, BAVE. Bureau of Audiovisual Education, University of North Carolina, 111 Abernethy Hall, Chapel Hill, N. C. 27515.

APPENDIX B

TITLE INDEX OF 16mm FILMS CITED IN TEXT OF GUIDE

America in Space, 52
Asteroids, Comets, and Meteorites, 22
The Astronomer, 39

Balance of Life and the Space Age, 55
Be Your Own Weatherman, 87
Before Saturn, 58
Bell Solar Battery, 37
Beyond Our Solar System, 39
The Biosatellite Program: Between the
  Atom and the Star, 53

Causes of the Seasons, 26
Celestial Mechanics and the Lunar Probe, 29, 54
Clouds Above, 85
Clouds of Venus, 22
Cold Front, 86

Eclipse of the Quiet Sun, 37
Exploring the Moon, 29

Father of the Space Age, 57
First Men into Space, 55
The Flaming Sky, 37
Flight of the Faith "7", 53
Fog and Low Ceiling Clouds, (FAN 101 and 102), 83
The Four Days of Gemini 4, 55
Freedom Seven, 58
Friendship Seven, 53
Frontiers in Space, 40

Global Concepts in Maps, 26
Gravity, Weight and Weightlessness, 58
Great Winds, Pt. 1, 83
Great Winds, Pt. 2, 84

The Hard Ones, 61
How Do We Know the Earth Moves?, 26
How Man Travels in Space, 52
How Many Stars?, 40
How Vast Is Space?, 40
How We Explore Space, 52
Hurricane Hunters, 87

Inside the Weather, 82

John Glenn Speaks to Young Americans, 52
The John Glenn Story, 53

Living in Space, 55
Lunar Bridgehead, 62

Magnetic Force, 26
Magnetosphere, 61
Mars and Beyond, 22
Martian Explorer, 64
The Mastery of Space, 52
Milky Way, 40
Molecules to Missiles, 58
The Moon, 30

Our Mr. Sun, 37
Outer Space, 40

Pioneers in Space, 52
Planets in Orbit: The Laws of Kepler, 22
Portrait of the Sun, 37
Project Apollo--Manned Flight to the Moon, 64

Race for Space, 53
Research by Rockets, 57
Rockets: Principles and Safety, 57
Rockets and Satellites, 57

Saturn: Giant Step to the Moon, 53
Science in Space, 53
The Shape of Things to Come, 54
Solar Family, 22
Space Science: Comets, Meteors, and Planetoids, 23
Spacemobile, 58
Steps to Saturn, 54
Strange Case of Cosmic Rays, 41

Telstar, 61
Tides of the Ocean, 30
Tiros II--Experimental Weather Satellite, 61
Toward the Unexplored, 53
Trial Balance, 54
Trip to the Moon, 30
A Trip to the Planets, 23

Unchained Goddess, 82
The Universe, 41

A Voice for Mercury, 61
Voyage to the Moon, 64

Warm Front, 86
Water in the Air, 85
Weather, Why It Changes, 86
What Are Stars Made Of?, 41

What is Space?, 41
What Makes Weather?, 85
When Air Masses Meet, 85,86
Why Communication Satellites?, 61
Why Explore Space?, 52
Winds Great and Small, 84

X-15 Documentary, 53

TITLE INDEX OF 35mm FILMSTRIPS CITED IN TEXT OF GUIDE

Abnormal Stars, 41
Air Pressure, 82

Between the Stars, 41

The Changing Moon, 30
Conditions in Space, 56

Earth and Moon, 30
The Earth as a Planet, 26
Earth Satellite--A Man Made Moon, 58
Earth's Atmosphere, 82
Earth's Magnetism, 26
Earth's Nearest Neighbor, 30
The Earth's Shape and Size, 26
Exploring the Space Around the Earth, 58
Eyes and Ears, 41

Heat and the Atmosphere, 86
How Far Are the Stars?, 41
How Gravity Works, 56
How We Learn About the Sky, 41

Interesting Things About the Planets, 23

Leaving the World, 58
The Life of a Star, 41

Man in the Universe, 23
Man's Preparation for Space, 56
Milky Way, 41
Moisture in Atmosphere, 85
More About the Stars, 41
Motions of the Earth in Space, 27

Physical Properties of Air, 82
Project Apollo: Manned Flight to the Moon, 65

Rocket Power for Space Travel, 58
Rocket to the Moon, 65

Sun's Awesome Impact, 38

The Universe, 41

What Is Air Pressure?, 82
Why Does It Rain, Snow, Hail, and Sleet?, 85
Why Does the Weather Change?, 86
Why Does the Wind Blow?, 84
Why the Stars?, 41
Wind, 88

APPENDIX C

SOURCES OF MATERIALS: BIBLIOGRAPHIES, GUIDES, AND MISCELLANEOUS PUBLICATIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

For a complete list of NASA publications write for

NASA EDUCATIONAL PUBLICATIONS
Educational Publications, FAD-1
National Aeronautics and Space Administration
Washington, D. C. 20546

Examples of NASA publications available. Request from above address, unless otherwise specified.

Booklets and Folders

Space, the New Frontier.

This 72-page booklet on all aspects of space and space exploration has good drawings and photographs, as well as a Glossary of frequently used space terms, prepared by NASA.

Historical Sketch of NASA.

A brief accounting of the origin and early history of the National Aeronautics and Space Administration.

Space Exploration--Why and How, by Edgar M. Cortright, Deputy Associate Administrator for Space Science and Applications, NASA.

This publication poses the question "Why explore space?" and provides answers in terms of the mission of NASA and the programs which have been undertaken to find these answers.

A Walk in Space.

A picture book, with a full color cover, of Astronaut White's historic 21-minute walk in space. Pictures and text describe GT-4's preflight, launch, the Extra Vehicular Activity (EVA), splash down and recovery.

NASA Facts

NASA Facts describes NASA programs, with photographs and diagrams of the spacecraft and launch vehicles. Sheets are designed for bulletin board display, or for insertion in looseleaf notebooks when cut, folded, and punched in accordance with directions supplied.

If you request NASA Facts you will be placed on the mailing list for all future issues. Note: If you have requested listing for NASA Facts within the last 12 months, your name will be retained on the list. Please do not make a duplicate request.

United States Launch Vehicles for Peaceful Exploration of Space (NASA Facts, Fol. II, No. 5)

Accompanied by color supplement suitable for bulletin board display.

This is NASA.

A brief description of NASA's past, present and future programs.

Educational Programs and Services.

A folder that discusses briefly the NASA services and programs available for teachers and students.

Investigating Science with Children.

Six handbooks for the teaching of science at the elementary level, published as the result of a joint project of the National Science Teachers Association and the National Aeronautics and Space Administration. List of six titles given in NASA Educational Publications with publisher and price.

NASA 16mm Film List. Distribution Branch, Code FAD-2, NASA, Washington, D.C. 20546.

Annotated list of 16mm motion pictures giving information on length, description of contents, and information on use. A list of the addresses of the NASA film libraries in each area is given with a map showing the boundaries of each area. Supplemented with new film titles as they become available.

Space Story: A series of Audio Tape Reports on the Peaceful Exploration of Space. For availability write to the National Aeronautics and Space Administration, Code FAV, Washington, D.C. 20546.

Radio-Television Production Aids: NASA Production Aids for Television. Available from National Aeronautics and Space Administration, Television-Radio Program, Code FAV, Washington, D.C. 20546.

Divided into five parts covering film clips, flat pictures, audio tapes, and 2" x 2" color slides, this publication describes each subject and at the beginning of each part the terms of use are explained.

Bibliographies

Aerospace Bibliography. Third edition. This new edition of the bibliography, with all the material in one publication and with titles keyed to grade levels, is scheduled for publication in early 1966.

Compiled for NASA by National Aerospace Education Council, this annotated bibliography is divided into three sections: Books, Reference materials, and Teaching aids, including films, filmstrips. and inexpensive teaching materials. All entries are keyed to indicate grade levels.

Aeronautics and Space Bibliography, for Elementary Grades. Second Edition. Washington: 1963. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $ .30.

Aeronautics and Space Bibliography for Secondary Grades. Second Edition. Washington: 1963. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $ .35.

Aerospace Information Index: Aerospace Resource List of Films and Brochures for Educators. Available from Mr. Mike Donahoe, Educational Programs and Services, NASA, 150 West Pico Boulevard, Santa Monica, California, 90406.

Brief annotations for Film List which is divided into broad areas of aircraft films, space films, and general. Sources for obtaining films or brochures listed in Part Two are given.

NATIONAL AEROSPACE EDUCATION COUNCIL, 806 Fifteenth Street, NW. Washington. D. C. 20005. PUBLICATIONS:

Aviation Education Bibliography. Compiled by Jane N. Marshall. Fourth Edition. Washington, D. C., 1964. Available from National Aerospace Education Council. Price $ .25.

Annotated list of books, references, periodicals, films, filmstrips, and other teaching aids related to aviation and flight in atmosphere.

Free and Inexpensive Pictures, Pamphlets, and Packets for Air/Space Age Education. Compiled by Jane N. Marshall. Fifth Edition. Washington, D. C., 1964.

A list of free and inexpensive aerospace teaching aids produced by government agencies, airlines, aerospace manufacturers, and organizations. Information is given concerning availability, coverage, price, and address of source.

Skylights: monthly publication during the school year. Available upon request to National Aerospace Education Council.

United States Aircraft, Missiles and Spacecraft, 1964. Edited by James J. Haggerty, Jr., Available from the National Aerospace Education Council, 1964.

Pictorial presentation of the highlights of aerospace progress in 1963.

NOTE: For other National Aerospace Education Council publications, write for List of Aerospace Packets, Books, Units, Guides, and Pictures.

EROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC., 1725 DeSALES STREET, WASHINGTON 6, D. C. PUBLICATIONS:

Aerospace: quarterly publication. Vol. 1- 1963- Available upon request.

Aerospace Technical Forecast, 1962-1972. Washington, 1962. Price $3.00.

Graphic presentations of aerospace research on areas such as system trends, propulsion trends and requirements, etc.

OTHER SOURCES:

Educators Guide to Free Films, 24th Annual Edition, 1964. Educators Progress Service, Randolph, Wisconsin. Price $9.00.

A classified list of 16mm motion pictures available free of cost, this guide has a title, subject, and source index. Complete addresses of distributing agency or company are given as well as limitation on use of films, e.g., television.

Educators Guide to Free Science Materials. 5th Annual Edition, 1964. Educators Progress Service, Randolph, Wisconsin. Price $7.25.

Classified index to free films, filmstrips, slides, charts, bulletins, pamphlets, exhibits, posters, and books. Fully indexed by title, subject, and source. The Appendix has twelve units outlined showing the use of the free materials available in this edition, including units on Newton's Third Law and Space Age problems.

George Peabody College for Teachers. Division of Surveys and Field Services. Free and Inexpensive Learning Materials. 12th Edition, 1964-65. Nashville, Tennessee. 1964. Price $2.00.

Annotated list of teaching aids with sources, addresses, prices if not free. Sections on Astronomy, Aviation, Space Exploration, and Weather and Climate.

North Carolina. Department of Public Instruction. Science: Grades 7-9. Raleigh, N. C. June, 1964.

Prepared under the direction of Y. A. Taylor and the Science Education Staff of the State Department of Public Instruction, this suggested course of study is accompanied by laboratory experiements and bibliographies of books for each area and grade level. The Appendixes also give lists of equipment and supplies necessary for each of the courses of study. No publishers' addresses and prices are given, but a note is added referring users to Books in Print and Paperbound Books in Print, which are usually available in local libraries.

Oths, Florence V. Teaching to meet the Challenges of the Space Age: A Handbook in Aerospace Education for Elementary School Teachers. Washington, D. C. November, 1963. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Price $ .40.

Although designed as a handbook in aerospace education for elementary teachers, the examples of interrelated curriculum planning are excellent for other levels of teaching as well. The source lists, glossary, and brief annotations of films are all well done. The publication is the product of an aerospace instructional materials project of the Office of Educational Programs and Services of NASA and the State University College at Plattsburgh, New York.

Pennsylvania. Department of Public Instruction. Earth and Space Science: A Guide for Secondary Teachers. Reprinted by National Aerospace Education Council, 1025 Connecticut Avenue, N.W., Washington 6, D. C. Price $1.50.

A revised and enlarged edition of the Teaching Guide for the Earth and Space Science Course which was developed and used in Pennsylvania secondary schools. Appendices describe teaching materials and demonstrations. Source is given for each film in the section on films. A fairly complete bibliography of books on Geology, Astronomy, Meteorology, and Space Study is given, including place, publisher, and date. Address of publisher and price of books are not given.

MISCELLANEOUS PUBLICATIONS AND REPRINTS

"Can You Talk the Language of Aerospace Age?" Hq. USAF Recruiting Service, Wright-Patterson AFB, Ohio.

An attractively prepared Glossary of Aerospace Age Terms, accompanied by drawings of USAF aerospace craft.

Ranger, 1964-65. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, July, 1964. Available upon request.

Thirty-four page pamphlet, illustrated with photographs, graphics, and charts on the lunar explorations.

Space Atlas. Text by U. S. Naval Institute. Available from American Map Company, Inc. 347 Madison Avenue, New York, N. Y.

Fifty-page pamphlet giving information on the universe, solar system, moon, earth in space, tide, calendar, time, etc. In addition to a detailed moon map, the text is illustrated with space photographs, space vehicles, photographs, and diagrams.

Space Primer: An Introduction to Astronautics. General Dynamics/ Astronautics, A Division of General Dynamics, San Diego, California.

Seventy-two page booklet outlining origins of astronautics, the rocket, propulsion, satellites, travel in the solar system. Each section is accompanied by drawings or charts. Brief bibliography and glossary at end of booklets.

Space Travel: A reprint from the World Book Encyclopedia, Field Enterprises, Chicago, Illinois.

Beautifully illustrated, with both color and black and white, including photographs, drawings, and diagrams.

CURRENT PERIODICALS:

Missiles and Rockets. Weekly. American Aviation Publications, Inc. 1001 Vermont Avenue, N. W., Washington, D. C. 20005. $5.00 per year.

Sky and Telescope. Monthly. Sky Publishing Corporation, Harvard College Observatory, Cambridge, Massachusetts. $6.00 per year.

The Review of Popular Astronomy. Bi-monthly in February, April, June, August, October, and December. Sky Map Publications, Inc., 214 South Bemiston Avenue, St. Louis, Missouri. 36105. $4.00 per year.

Space Science. Monthly, except July and August. Benjamin Adelman, 4211 Colie Drive, Silver Spring, Maryland. $1.00 per year.

PAPERBACK BOOKS

Space Science Series

The fourteen books involve students in the methods, principles and discoveries of scientists and engineers working in significant and specific areas of space exploration. Many were written by NASA scientists and managers. Holt, Rinehart and Winston. Set of 28 books (2 copies of each title): $38. Individual titles, $1.96. c1965 and 1966.

Ahrendt, Myrl H. *The Mathematics of Space Exploration*.

Eugene M. Emme. *A History of Space Flight*.

Max Faget. *Manned Space Flight*.

Marjorie H. Gardner. *Chemistry in the Space Age*.

Harold Leland Goodwin. *The Images of Space*.

James P. Henry. *Biomedical Aspects of Space Flight*.

Maxwell W. Hunter, II. *Thrust Into Space*.

Edward Hymoff. *Guidance and Control of Spacecraft*.

Leonard Jaffe. *Communications in Space*.

John E. Naugle. *Unmanned Space Flight*.

Phillip D. Stern. *Our Space Environment*.

Richard M. Sutton. *The Physics of Space*.

William K. Widger, Jr. *Meteorological Satellites*.

Richard S. Young. *Extraterrestrial Biology*.

Vistas of Science Series

Three of the titles in this science series developed by the National Science Teachers Association are on space subjects and represent cooperation between NSTA and NASA. Scholastic Book Services, 33 West 42d Street, New York, N.Y. Each title, 50¢.

Haggerty, James J., Jr. *Spacecraft* c1962. (A new edition is scheduled for publication in early 1966).

Hynek, Allen and Norman Anderson. *The Challenge of the Universe*. c1962.

Moffat, Samuel and Elie A. Shneour. *Life Beyond the Earth*. c1965.

Paperback Books--cont'd.

Armitage, Angus. The World of Copernicus. (Original Title: Sun, Stand Thour Still) Mentor Book (MD65) New American Library. 50¢ c1947.

Barnett, Lincoln. The Universe and Dr. Einstein. Mentor Book (MP435) New American Library. 60¢ c1957.

Burgess, Eric. Frontier to Space. New revised edition. Collier Books. (AS456V) 95¢ c1962.

Clarke, Arthur C. The Exploration of Space. revised edition. A Premier Book. (d102) Fawcett Publications. c1959.

Dantzig, Tobias. Number: The Language of Science. Fourth edition, revised and augmented. Doubleday Anchor Books. (A67) c1954 95¢.

Gamow, George. The Birth and Death of the Sun. Mentor Book. (MD120) New American Library. c1952. 50¢.

Honegger, Gottfried and Peter van de Kamp. Space: The Architecture of the Universe. (Visual, Volume 1) (VT1) Dell Publishing Company. c1962. 95¢.

Hoyle, Fred. Frontiers of Astronomy. Signet Science Library Book. (T2309) New American Library. c1955. 75¢.

_______ ___________. The Nature of the Universe. Revised Edition. Mentor Book, (MP409) New American Library. c1960. 60¢.

Jeans, Sir James. The Growth of Physical Science. Second Edition. Premier Book (d70) Fawcett Publications. c1951. 50¢.

Ley, Willy. Satellites, . . Rockets, and Outer Space. Newly Revised. Signet (P2218) New American Library. c1962. 60¢.

Motz, Lloyd. This is Outer Space. Signet Book. (P2084). New American Library. c1960. 60¢.

Opik, Ernst J. The Oscillating Universe. Mentor Book. (MD289). New American Library. c1960.

Ovenden, Michael W. Life in the Universe: A Scientific Discussion. Anchor Books. (Science Study Series S23) Doubleday & Co. c1962 95¢.

Paperback Books--cont'd.

Shapley, Harlow. Of Stars and Men: The Human Response to an Expanding Universe. (W601) Washington Square Press Book. c1958. 50¢.

Smith, F. Graham. Radio Astronomy. Penguin Books. (A497) c1962. $1.65.

Thomas, Shirley. Men of Space. Hillman Book. (50-101) c1960. 50¢.

Uvarov, E. B. A Dictionary of Space. Revised. Penguin Reference Books (R 1) 1962, 95¢.

ADDITIONAL TITLES IN PAPERBACK:

For additional titles, see Books in Print and Paperback Books in Print. New York: Bowker, 1964.

KEY TO PAPERBACK SERIES PUBLISHERS:

American Aviation Publications, 1001 Vermont Avenue, N.W., Washington 5, D. C.

Anchor Book. Doubleday & Company, Inc., Garden City, New York.

Collier Books. Crowell0Collier Publishing Company, New York, New York.

Dell Publishing Company, Fawcett World Library, 67 West 44 Street, New York, New York 10036.

Doubleday Anchor Books. Doubleday & Company, Inc., Garden City, New York.

Hillman Book. Bartholomew House, Inc., 205 East 42 Street, New York, New York. 10017.

Holt Library of Science Series. Holt, Rinehart, & Winston, Inc., New York, New York.

Mentor Book. New American Library of World Literature, Inc., 501 Madison Avenue, New York, New York 10022.

Pelican Books. Penguin Books, Inc., 3300 Clipper Mill Road, Baltimore, Md.

Penguin Reference Books. Penguin Books, Inc., 3300 Clipper Mill Road, Baltimore, Maryland.

Premier Book. Fawcett World Library, 67 West 44 Street, New York, N. Y. 10036.

Signet, New American Library of World Literature, Inc., 501 Madison Avenue, New York, New York 10022.

Signet Science Library Book. New American Library of World Literature, Inc., 501 Madison Avenue, New York, New York 10022.

Vistas of Science. National Science Teachers Association. 1201 Sixteenth Street, N.W., Washington 6, D. C.

Washington Square Press Book. Affiliated Publishers, Inc., 630 Fifth Avenue, New York, New York.

APPENDIX D

SUPPLEMENTARY LIST OF FILMS AND FILMSTRIPS

* RECENT EBF FILMSTRIPS IN COLOR

The Earth in Space (Astronomy)

ASTRONOMY THROUGH THE AGES 48 fr
THE UNIVERSE IN COLOR 48 fr
THE MOUNT WILSON AND PALOMAR TELESCOPES 33 fr
MAN BECOMES AN ASTRONOMER 49 fr

The Solar System

PLANETS AND COMETS 33 fr
THE SOLAR SYSTEM 48 fr

The Earth (A Planet in Motion)

OUR EARTH 48 fr

The Moon

EXPLORING THE MOON 33 fr
THE MOON 48 fr

The Sun

THE SUN 48 fr
EXPLORING THE SUN 33 fr

The Stars, Constellations and Galaxies

NEBULAE 33 fr
THE MILKY WAY AND OTHER GALAXIES 33 fr
THE STARS 48 fr

Space Travel

FLIGHT TO MARS 49 fr
FLIGHT INTO SPACE 49 fr
MAN IN SPACE 49 fr

Moon Flight

FLIGHT AROUND THE MOON 49 fr
MAN AND THE MOON 49 fr

* RECENT SVE FILMSTRIPS IN COLOR WITH RECORDS

Understanding Our Earth and Universe

HOW MAN EXPLORES SPACE 60 fr
OUR SOLAR SYSTEM 54 fr
THE SUN AND ITS ENERGY 50 fr
THE STARS AND OUTER SPACE 61 fr
THE MOON AND ITS RELATION TO EARTH 59 fr
THE EARTH AND ITS MOVEMENTS 53 fr

Understanding Weather and Climate Changes

AIR MASSES AND WEATHER FRONTS 62 fr
WINDS AROUND THE WORLD 70 fr
HUMIDITY AND HOW IT AFFECTS US 70 fr
HOW TO FORECAST WEATHER 65 fr
MOISTURE AND PRECIPITATION IN THE AIR 65 fr
WEATHER CHANGES AND THEIR CAUSES 65 fr

* RECENT EBF 16mm FILMS (available in color or black and white)

Astronomy

CHARTING THE UNIVERSE WITH OPTICAL AND RADIO TELESCOPES 13 min
SPACE PROBES--EXPLORING OUR SOLAR SYSTEM 11 min
ECLIPSES OF THE SUN AND MOON 11 min
THE VAN ALLEN RADIATION BELTS--EXPLORING IN SPACE 17 min

Meteorology

ORIGINS OF WEATHER 13 min
WEATHER SATELLITES 15 min

* RECENT McGRAW HILL 16mm FILMS

The Solar System

THE COSMIC RAYS 27 min col/bw

The Sun

THE NEAREST STAR 27 min col/bw

The Stars

THE SKY AND THE TELESCOPE 15 min col/bw

Rocketry and Space Travel

HISTORY AND DEVELOPMENT OF THE ROCKET 16 min col/bw
THE RACE FOR SPACE 55 min bw

Moon Flight

INCONSTANT AIR 27 min col
THE GREAT WEATHER MYSTERY 27 min bw

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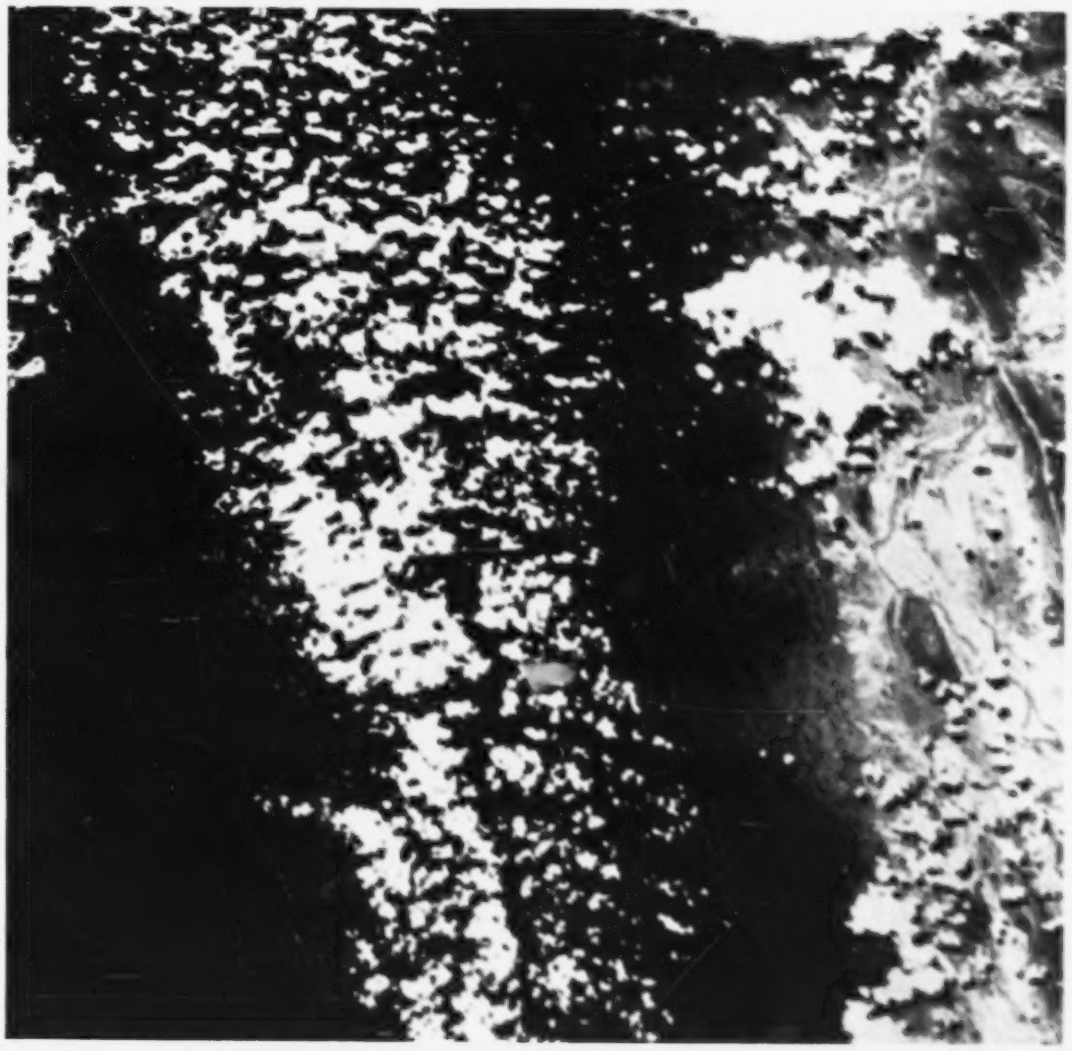
* For addresses of producers see Appendix A.
For titles of other films and filmstrips cited in _Guide_ see Appendix B.



BURMA

The contrast between land and ocean areas is particularly well portrayed in this picture taken by Astronaut Cooper as Faith 7 passed over the west coast of Burma, west of Rangoon. At left is the Bay of Bengal, at right is the Irrawaddy River.